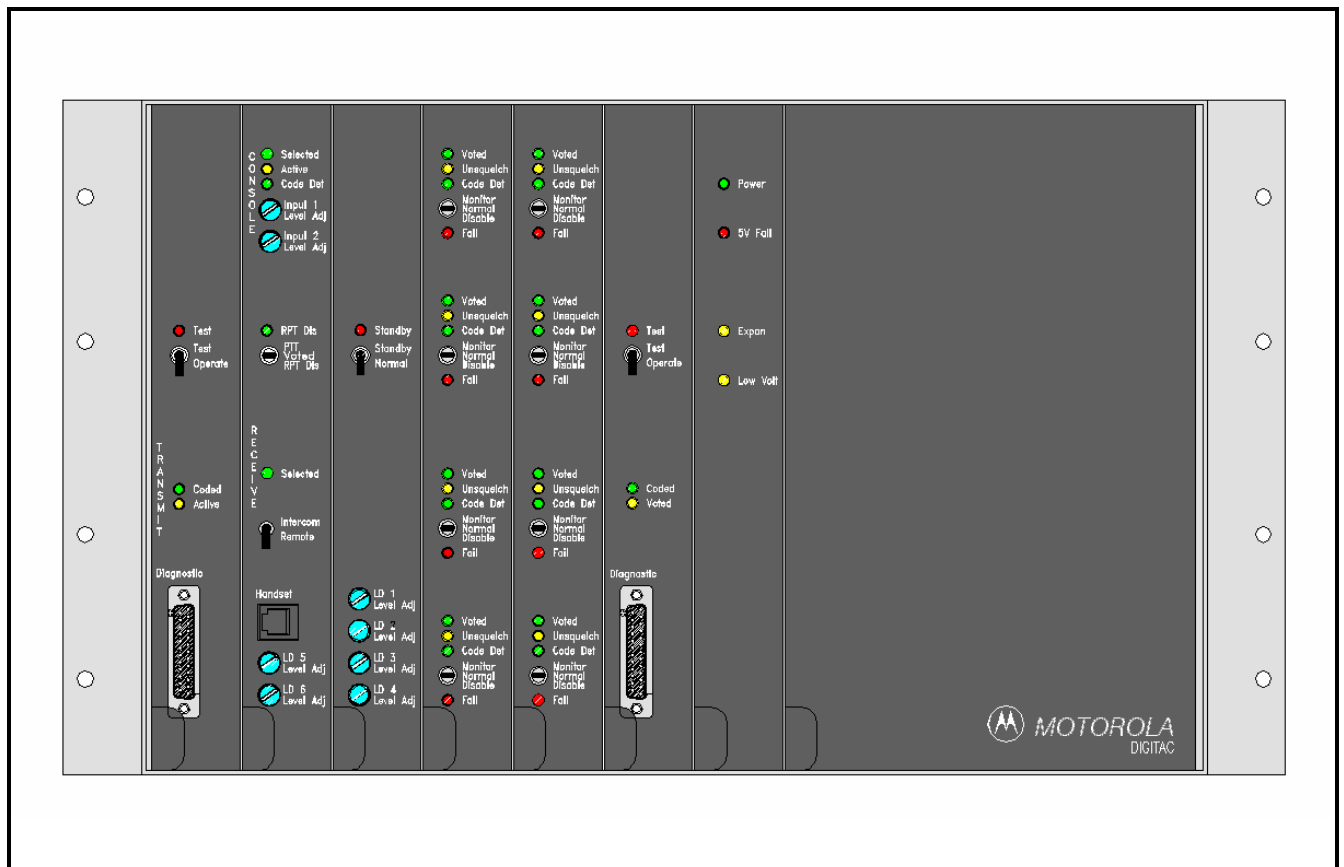




DIGITAC™ COMPARATOR Q2980 SERIES



Instruction Manual



68P06908B19-A

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APPENDIX

DIGITAC COMPARATOR SYSTEM GUIDE

OPTION C618AB/AF-SP AND QVN4119A RETROFIT KIT CODED VOTE/HOLD OPERATION

DIGITAC COMPARATOR VOTE SELECTION

DIGITAC COMPARATOR TUNES

MODEL CHART FOR DIGITAC™ COMPARATORS

CODE:

x = 1 item supplied
2 = number in box indicates
quantity supplied

MODEL NO.	DESCRIPTION	MODEL NO.	DESCRIPTION
Q2980A	4-CHANNEL COMPARATOR	QCN1218A	COMPARATOR CHASSIS
Q2981A	8-CHANNEL COMPARATOR	QCN6127B	CHASSIS
Q2982A	12-CHANNEL COMPARATOR	QGN6422A	CONNECTOR PANEL
Q2983A	16-CHANNEL COMPARATOR	QKN4024A	INTERNAL CABLE
Q2984A	20-CHANNEL COMPARATOR	QRN4542A	INTERCONNECT BOARD
Q2985A	24-CHANNEL COMPARATOR	QGN6418A	FRONT PANEL (SMALL)
Q2986A	28-CHANNEL COMPARATOR	QKN4021A	DC POWER CABLE
Q2987A	32-CHANNEL COMPARATOR	QKN4022A	EXPANSION CABLE (5")
Q2988A	36-CHANNEL COMPARATOR	QKN4023A	EXPANSION CABLE (39")
Q2989A	40-CHANNEL COMPARATOR	QKN4159A	EXPANSION CABLE (10")
		QKN4160A	EXPANSION CABLE (67")
		QRN4304B	KERNEL BOARD
		QRN4305B	PERIPHERAL BOARD
		QRN4306B	INPUT BOARD
		QRN4307B	OUTPUT BOARD
		QRN4328B	MOUNTING HARDWARE
		QRN4880A	NAMEPLATE
		THN6141A	31-INCH INDOOR CABINET
		THN6142A	41-INCH INDOOR CABINET
		THN6318A	46-INCH CABINET
		THN6243A	60-INCH INDOOR CABINET
		THN6316A	70-INCH INDOOR CABINET
		TRN9336A	RACK HARDWARE
		TRN9788A	BAFFLE
		TRN9789A	SPACER BRACKET
		TPN1239A	POWER SUPPLY



DIGITAC™ COMPARATOR

DESCRIPTION

MODEL Q2980A THROUGH Q2989A
4 TO 40 CHANNEL OPERATION

1. SYSTEM DESCRIPTION

1.1 The Motorola Digital Voice Protection (DVP) Total Area Coverage (T.A.C.) system (DIGITAC) is used to extend the useful range of DVP portable and mobile radios. The *DIGITAC* system employs multiple receivers at strategic locations (either directly connected to the *DIGITAC* comparator or connected through telephone line modems or microwave links) and a voting system to select the best quality signal received from a portable or mobile radio. This best quality signal is then passed to the output of the comparator.

1.2 Each remote receiver is connected to a dedicated channel in the comparator. When clear signals are received, the comparator selects the channel with the best signal quality and sends that audio to the output of the comparator. When coded signals are received, the comparator produces a composite signal consisting of information from all the signals received and determines the best incoming signal with the least bit error rate. The comparator then determines which signal will be sent to the comparator output; either the composite signal or the best incoming signal with the least bit error rate. At no time is a coded signal decrypted by the comparator. This insures that communication remains fully secure through the comparator circuits. If the secure audio is to be decrypted, the comparator output is fed to a CIU at the control console site so the audio remains secure all the way to the console site. The "**Voted**" LEDs on the input boards always indicate the channel with the best signal input regardless of which signal is output from the comparator; either the best signal input regardless of which signal is output from the comparator; either the best signal with the least bit error rate or the composite signal.

1.3 In a voting repeater system, a tone keying module with priority is utilized. In this case, the output of the comparator is sent to the tone keying module. The tone keying module sums in the necessary key up and key down sequences for control of the transmitter. The module also arbitrates the use of the transmitter between the comparator, a console, and the local handset.

1.4 Depending on the model, the comparator can provide channel capacity from 4 to 40 channels. Refer to the model breakdown chart for a full listing of the components contained in each model.

2. UNIQUE ITEM DESCRIPTION

2.1 QCN1218A Comparator Chassis

The QCN1218A Comparator Chassis consists of the following items:

- QCN6127B Chassis
- QKN4024A Internal Fuse Cable
- QRN4542A Interconnect Board
- QGN6422A Connector Panel

2.1.1 The QCN6127B Chassis contains the card cage and hardware that provides mounting facilities for the various circuit boards used in the comparator along with the QRN4542A Interconnect Board. The chassis also provides mounting facilities for the various input/output cable connectors.

2.1.2 The QKN4024A Internal Fuse Cable provides dc input power to the QRN4542A Interconnect Board of the comparator and also interconnects between the dc power supply input connector (P800), and the interconnect board. The interconnect board provides all signal paths and dc power distribution required between the plug-in circuit boards and the input/output signal and power connectors mounted on the chassis. Refer to attached instruction section 10S-SP5253351 for further detailed information.

2.2 QRN4304B KERNEL BOARD

The QRN4304B Kernel Board is a plug-in circuit board that contains a microprocessor, read only/memory (ROM), random access memory (RAM), watchdog timer circuit, and other input/output and control circuitry. The Kernel Board plugs into the QCN1218A Chassis. Refer to attached instruction section 20S-SP5252359 for further detailed information.

2.3 QRN4305B PERIPHERAL BOARD

The QRN4305B Peripheral Board is a plug-in circuit board that contains PIAs and SSDAs which condition and interface all the inputs to the microprocessor on the Kernel Board. The Peripheral Board plugs into the QCN1218A Chassis. Refer to attached instruction section 25S-SP5252359 for further detailed information.

2.4 QRN4306B INPUT BOARD

The QRN4306B Input Board is a plug-in circuit board that contains all the audio line input conditioning circuitry, comparators, and analog-to-digital converters required to change the analog inputs to digital form for use by the PIAs and SSDAs on the Peripheral Board. The Input Board plugs into the QCN1218A Chassis. Refer to attached instruction section 30S-SP5252359 for further detailed information.

2.5 QRN4307B OUTPUT BOARD

The QRN4307B Output Board is a plug-in circuit board that contains all the output conditioning circuitry and audio line drivers to match the audio output to a 600 ohm line. The Output Board plugs into the QCN1218A Chassis. Refer to attached instruction section 35S-SP5252359 for further detailed information.

2.6 QRN4328A HARDWARE KIT

The QRN4328A Hardware Kit contains the hardware required to mount the QCN1218A Comparator Chassis into a cabinet. Refer to the QRN4328B Hardware Kit parts list 101PL-SP5253351 for kit details.

2.7 QGN6418A FRONT PANEL

The QGN6418A Front Panel is a blank panel (Motorola Part No. 64-06934M01) used to cover unused card slots in the QCN1218A Comparator Chassis.

2.8 QKN4021A DC POWER CABLE

The QKN4021A DC Power Cable is used to connect the output of the TPN1239A Power Supply to the QCN1218A Comparator Chassis. Refer to attached parts list 102PL-SP5252359 for details.

2.9 TPN1239A 250 WATT POWER SUPPLY

The TPN1239A 250 Watt Power Supply provides all the dc operating power for the comparator chassis. Refer to attached instruction section 68P81071E76 for complete information regarding the power supply.

2.10 THN6141A, THN6142A, THN6243A, THN6316A, OR THN6318A CABINET

The THN6141A Cabinet is a 30 inch indoor cabinet that is used to house one QCN1218A Comparator Chassis and one TPN1239A Power Supply. The THN6142A Cabinet is a 41 inch indoor cabinet that is used to house two QCN1218A Comparator Chassis and one TPN1239A power Supply. The THN6318A Cabinet is a 46 inch indoor cabinet that is used to house three QCN1218A Comparator Chassis and one TPN1239A Power Supply. The THN6243A Cabinet is a 60 inch indoor cabinet that is used to house four QCN1218A Comparator Chassis and one TPN1239A Power Supply. The THN6316A Cabinet is a 70 inch indoor cabinet that is used to house five QCN1218A Comparator Chassis and one TPN1239A Power Supply. The type of cabinet supplied is determined by the comparator model purchased.

3. SYSTEM FUNCTIONAL OPERATION

3.1 GENERAL

3.1.1 The Motorola Digital Voice Protection Total Area Coverage (*DIGITAC*) system is used to extend the useful range of DVP portable and mobile radios. The *DIGITAC* system employs multiple receivers at strategic locations (either directly connected to the *DIGTAC* comparator or connected through telephone line modems or microwave links) and a voting system to select the best quality signal received from a portable or mobile radio. This best quality signal is then passed to the output of the comparator.

3.1.2 Each remote receiver is connected to a dedicated channel in the comparator. When clear signals are received, the comparator selects the channel with the best signal quality and sends that audio to the output of the comparator. When coded signals are received, the comparator produces a composite signal consisting of information from all the signals received and determines the best incoming signal with the least bit error rate. The comparator then determines which signal is sent to the comparator output; either the composite signal or the best incoming signal. At no time is a coded signal decrypted by the comparator. This insures that communication remains fully secure through the comparator circuits. If the secure audio is to be decrypted, the comparator output is fed to a CIU at the control console site so the audio remains secure all the way to the console site. The **Voted** LEDs on the input boards always indicate the channel with the best signal regardless of which signal is output from the comparator; either the best signal with the least bit error rate or the composite signal.

3.1.3 In a voting repeater system, a tone keying module with priority is utilized. In this case, the output of the comparator is sent to the tone keying module. The tone keying module sums in the necessary key up and key down sequences for control of the transmitter. The module also arbitrates the use of the transmitter between the comparator, a console, and the local handset. Depending on the model, the comparator can provide channel capacity anywhere from 4 channels to 40 channels. Refer to the model breakdown chart for a full listing of the components contained in each model.

3.2 AUDIO CIRCUITS

3.2.1 Each audio channel has its own input circuit, AGC circuit, clear signal noise level measurement circuit, status tone detector circuit, and code detector circuit. These circuits are identical for each channel, therefore, only the circuits for one channel will be discussed. The audio input enters the comparator through an attenuator circuit and a line input transformer. The audio may be clear audio (no encryption) or coded audio (encrypted audio). The attenuator circuit which is ahead of the input line transformer is a fixed attenuator of 15dB. The audio input impedance is adjustable (via jumper) for 600 or 900 ohms. The output of the line transformer is routed to

the loopback gate circuit which is used to switch internally generated audio into the comparator circuits during diagnostic routines.

3.2.2 The output of the loopback gate is routed to the input of the status tone detector and to the input of the AGC circuit. If there is no clear or coded audio activity on the channel, then status tone is placed on the channel input by the receiver. The output of the status tone detector indicates this condition to the microprocessor through the PIA's on the peripheral board. If there is clear or coded audio present at the output of the loopback gate, the microprocessor adjusts the gain of the AGC circuit to achieve the same audio level for all active audio inputs to the comparator. The audio output of the AGC circuit is routed to the code detector circuit, the signal level detect circuit, the input of the clear signal noise level measurement circuit, and to the voted audio selector circuit on the output board.

3.2.3 If the audio at the output of the AGC circuit is coded audio, the code detector provides an indication to the microprocessor of this condition through the PIAs on the peripheral board. The signal level detector performs a measurement of signal level. The output of the signal level detector is digitized by the A/D converter and routed to the microprocessor through the PTAs on the kernel board. At the same time, the coded audio is routed to the SSDA on the peripheral board. Since it is the job of the comparator to select the best audio from multiple receivers listening to a single transmitter, the coded audio from all the receiver channels is routed to the microprocessor through the SSDAs on the peripheral board. The microprocessor compares all the coded signal inputs and selects the input signal with the least bit error rate and generates a composite signal made up from all the channels receiving the coded signal. The microprocessor then compares the quality of the best coded signal and composite signal to determine the best of the two signals. Based on the outcome of the comparison, the microprocessor allows the voted audio selector to apply the best signal to the line drivers.

3.2.4 If the audio at the output of the AGC circuit is clear audio, it is routed to the signal level detector and to the clear signal noise level measurement circuit. Since it is the job of the comparator to select the best audio from multiple receivers listening to a single transmitter, the output signals of all the signal level detectors and clear signal noise level measurement circuits are fed through an A/D converter to the microprocessor. The microprocessor determines which clear audio signal is the best signal and allows that signal to be passed through the voted audio selector to the output line drivers. If, at any time, the comparator is receiving clear signals and a coded signal is received, the coded signal has priority and the comparator always votes the coded signal rather than the clear signal.

3.3 CONTROL LINE DESCRIPTION

3.3.1 Active Channel "N"

The active channel output lines to the console are analogous to the **Unsquelled** LED on the front panel of the input boards. There are eight lines, one for the status of each channel. The lines are normally pulled high, therefore a low on a line (transistor switch to ground) indicates an active condition.

3.3.2 Module Active

The module active line to the console is analogous to the **Voted** LED on the front panel of the kernel board. This line remains inactive during power-up diagnostics. The line is normally pulled high, therefore a low voltage on this line (transistor switch to ground) indicates an active condition.

3.3.3 Module Coded PTT

The module coded PTT output line to the console is analogous to the **Coded** LED on the front panel of the kernel board. This line remains inactive during power-up diagnostics. The line is normally pulled high, therefore a low voltage on this line (transistor switch to ground) indicates a coded PTT condition.

3.3.4 Mode Channel "N"

The mode channel output lines to the console are analogous to the **Coded** LED on the front panel of the input boards. There are eight of these lines, one for the status of each channel. The line is normally pulled high, therefore a low voltage on this line (transistor switch to ground) indicates a coded signal on that specific channel.

3.3.5 Fail/Disable Channel "N"

The fail/disable channel bi-directional lines to the console are analogous to the **Disable** switch and **Fail** LED on the input boards. There are eight of these lines, one for each channel. These lines are normally pulled high, therefore a low voltage (switch to ground) initiated by the control console is a command to the comparator to disable the channel. If the line is pulled low by the circuitry in the comparator (transistor switch to ground), it is an indication that the channel has failed or the **Disable** switch on the input board is placed in the **Disable** position.

3.3.6 Vote/Monitor Channel "N"

The vote/monitor channel bi-directional lines to the console are analogous to the **Monitor** switch and **Voted** LED on the input boards. There are eight of these lines, one for each channel. These lines are normally pulled high, therefore a low voltage (switch to ground) initiated by the control console is a command to the comparator to force vote the specific channel. If the line is pulled low by the circuitry in the comparator (transistor switch to ground), it is an indication that the channel is voted by the comparator or that the corresponding **Monitor** switch on the input board is placed in the **Monitor** position.

3.3.7 Clear Disable

The clear disable input line from the console is normally pulled high, therefore a switched low (switch to ground) initiated by the control console instructs the comparator to not vote any clear signals. Activating this signal and the coded disable signal described below, at the same time causes the comparator to output status tone.

3.3.8 Coded Disable

The coded disable input line from the console is normally pulled high, therefore a switched low (switch to ground) initiated by the control console instructs the comparator to not vote any coded signals. Activating this signal and the clear signal described above, at the same time causes the comparator to output status tone.

3.3.9 Standby Request

The standby request input from the control console is analogous to the **Standby/Normal** switch on the output board. This line is normally pulled high therefore, a low on this line (switched ground) initiated by the control console instructs the comparator (all modules) to revert to STANDBY operation.

3.3.10 Unit Reset

The unit reset input line from the control console is analogous to the **Test/Operate** switch on the kernel board. This line is normally pulled high, therefore a low on this line (switched ground) initiated by the control console causes the microprocessor on all of the kernel boards in the comparator cabinet to be held in the RESET state. Allowing this line to return high, causes the comparator to execute the power-up diagnostic routine.

3.4 STATUS TONE GENERATING CIRCUIT AND DIAGNOSTICS

The comparator contains self diagnostics to isolate possible faulty circuits and audio channels. The microprocessor on the kernel board generates a status tone through the counter circuit on the peripheral board. The microprocessor generated status tone is routed to the output board where it is used for internal diagnostics. The diagnostic status tone is also routed back into the comparator via the test input line into the loopback gate circuit. Signal quality measurements and the operation of the microprocessor controlled AGC circuit are performed using this diagnostic status tone. Faulty channels are isolated during this diagnostic procedure with any failures being indicated via the **Fail** lights on the input boards or at the control console.

3.5 COMPARATOR CONTROL CIRCUITRY

3.5.1 The functions of the comparator may be monitored and/or controlled from the front panel controls on the comparator circuit boards or from the control console. The monitor functions include the following:

- Active channel indication for each channel
- Clear/coded audio indication for each channel
- Fail indication for each channel
- Voted indication for each channel
- Console test indication
- Module active

The controls available are:

- Channel Disable
- Clear Disable
- Coded Disable
- Standby
- Force Vote/Monitor
- Test/Unit Reset

3.5.2 All of these monitor and control functions are routed between the comparator and control console on a 50-wire cable that connects to P805 on the comparator chassis. Refer to attached Installation section 50S-SP5253351 for connection details.

3.6 OTHER INPUTS/OUTPUTS

A service input/output function is provided through an RS232 port which allows a terminal to be interfaced with the microprocessor on the kernel board. The microprocessor may be queried via the external terminal for diagnostic purposes. An RS422/485 port is provided on the comparator which is routed to P803 and P804 for system expansion. In 16 or 24-channel comparator systems, the expansion ports (P803, P804) are wired in a ring configuration to provide control and communication between the kernel boards in each chassis. Refer to Installation section, 50S-SP5253351 for details.

3.7 POWER SUPPLY

3.7.1 Most of the circuitry in the comparator operates from 13.8V dc which is supplied by the TPN1239A 250-Watt Power Supply mounted in the cabinet. If standby battery backup power is available, the comparator operates from the standby battery backup supply if the TPN1239A Power Supply fails for any reason.

3.7.2 The microprocessor on the kernel board requires regulated 5V dc for the 13.8V dc power supply and provides a regulated source for the kernel board. The output of the 5-volt regulator is fed to the kernel board to power the microprocessor.



INSTALLATION AND TROUBLESHOOTING

MODEL Q2980A THROUGH Q2989A

DIGITAC™ COMPARATOR

1. ATTACHMENTS

-- Comparator Card Cage Functional Block Diagram	3-SP5253351
-- System Interconnect Diagram	4-SP5253351
-- Station Cabinets Dimensional Details and Parts Lists Sheet 1	PEPS-17767-1
-- Station Cabinets Dimensional Details and Parts Lists Sheet 2	PEPS-17767-2

2. GENERAL

This document describes the installation and operation of the DIGITAC™ comparator in sufficient detail to enable a user to install and operate the comparator. In addition, sufficient information is included to allow a user to troubleshoot problems caused by malfunctions in the comparator itself, or in the input/output line connections supplied to the comparator.

2.1 SYSTEM DESCRIPTION

2.1.1 The Motorola Digital Voice Protection (DVP) Total Area Coverage (TAC) system (*DIGITAC*) is used to extend the useful range of the Motorola SECURENET™ portable and mobile radios. The *DIGITAC* system employs multiple receivers at strategic locations that are either directly connected to the *DIGITAC* comparator or connected through telephone line modems or microwave links. The receivers and the comparator form a voting system to select the best quality signal received from a portable or mobile radio. The comparator makes extensive use of microprocessor technology (especially the Motorola MC68000 microprocessor), to achieve a very high level of system performance. The microprocessor compares the quality of the input signals from each of the receivers to determine the signal with the best quality. This best quality signal is then passed to the output of the comparator.

2.1.2 Each remote receiver is connected to a dedicated channel in the comparator. When clear signals are received, the comparator selects the channel with the best signal quality and sends that audio to the output of the comparator. When coded signals are received, the comparator produces a composite signal consisting of information from all the signals received and determines the best incoming signal with the least bit error rate. The comparator then determines which signal will be sent to the comparator output; either the composite signal, or the best incoming signal with the least bit error rate. At no time is a coded signal decrypted by the comparator. This insures that communication remains fully secure through the comparator circuits. If the secure audio is to be decrypted, the comparator output is fed to a CIU at the control console site so the audio remains secure all the way to the console site. The "Voted" LEDs on the Input boards always indicate the channel with the best signal input regardless of which signal is output from the comparator; either the best signal with the least bit error rate or the composite signal.

2.1.3 Depending upon model, the comparator provides a capacity of between 8 and 64 channels. A single comparator chassis interfaces with up to 8 receiver inputs. To add additional channels to a comparator system, an expansion capability is built into the *DIGITAC* comparator such that additional chassis may be added to the comparator (each chassis interfacing with up to 8 inputs). The chassis are connected together with an expansion cable to interconnect the audio and control signals to allow the chassis to switch the best channel to the output. Up to 8 comparator chassis may be interconnected in this manner to provide a capacity for up to 64 channels.

2.2 SYSTEM FUNCTIONAL OPERATION

This section covers the fundamental operation of the *DIGITAC* comparator. This is intended to give the user some understanding of comparator operation without discussing intricate details.

2.2.1 Audio Circuits

2.2.1.1 Each audio channel has its own input circuit, AGC circuit, clear circuit, and code detector circuit. These circuits are identical for each channel, therefore, only the circuits for one channel will be discussed. The audio input enters the comparator through an attenuator circuit and a line input transformer. The audio may be clear (no encryption) or coded (encrypted audio). The attenuator circuit (ahead of the input line transformer), is a fixed attenuator of 15dB. The output of the line transformer is routed to the loopback gate circuit that is used to switch internally generated audio into the comparator circuits during diagnostic routines.

2.2.1.2 The output of the loopback gate is routed to the input of the status tone detector and to the input of the AGC circuit. If there is no clear or coded audio activity on the channel, then status tone is placed on the channel input by the receiver. The output of the status tone detector indicates this condition to the microprocessor through the PIAs on the Peripheral board. If there is clear or coded audio present at the output of the loopback gate, the microprocessor adjusts the gain of the AGC circuit to achieve the same audio level for all active audio inputs to the comparator. The audio output of the AGC circuit is routed to the code detector circuit, the signal level detect circuit, the input of the clear signal noise level measurement circuit, and to the voted audio selector circuit on the output board.

2.2.1.3 If the audio at the output of the AGC circuit is coded, the code detector provides an indication to the microprocessor of this condition through the PIAs on the Peripheral board. The signal level detector performs a measurement of signal level. The output of the signal level detector is digitized by the A/D converter and routed to the microprocessor through the PIAs on the Kernel board. At the same time, the coded audio is routed to the SSDA on the Peripheral board. Since it is the job of the comparator to select the best audio from multiple receivers listening to a single transmitter, the coded audio from all the receiver channels is routed to the microprocessor through the SSDAs on the Peripheral board. The microprocessor compares all the coded signal inputs and selects the input signal with the least bit error rate and generates a composite signal made up from all the channels receiving the coded signal. The microprocessor then compares the quality of the best coded signal and composite signal to determine the best of the two signals. Based on the outcome of the comparison, the microprocessor allows the voted audio selector to apply the best signal to the line drivers.

2.2.1.4 If the audio at the output of the AGC circuit is clear, it is routed to the signal level detector and to the clear signal noise level measurement circuit. Since it is the job of the comparator to select the best audio from multiple receivers listening to a single transmitter, the output signals of all the signal level detectors and clear signal noise level measurement circuits are fed through an A/D converter to the microprocessor. The microprocessor determines when clear audio signal is the best signal and allows that signal to be passed through the voted audio selector to the output line drivers. If at any time the comparator is receiving both a clear signal and a coded signal, then a priority decision is made. If coded priority is active, then the coded signal is voted and the clear signal is suppressed. If clear priority is active, then the clear signal is voted and the coded signal is suppressed.

2.2.2 Indicators and Controls

2.2.2.1 There are several indicators and controls for the comparator. Some are specific for each channel and are replicated once per channel. Others are more global in nature and only function on a chassis. For installations with multiple chassis, these signals are replicated once per chassis. The last set of indicators and controls basically act over the entire comparator system and are connected to each chassis via the expansion connector. In this case, assertion of the function on any chassis will cause the entire comparator to act according to the action of the function.

2.2.2.2 For each channel there are 4 indicator LEDs and 1 switch. The LEDs indicate the Voted state, the Unsquelled state, the Code Detect, and the Fail state of the channel. The switch is a three-position switch that allows service personnel to either Monitor or Disable the channel. These functions give a simple display of the state of the channel input and allow service personnel to assert simple controls on the channel. These indicators and switches are located on the front panel of the comparator.

2.2.2.3 In addition to these indicators and controls, there are separate inputs and outputs that closely match the functions on the front panel. These are separately wired through a 25 pair ribbon connector on the chassis for connection to a console or other control device. There are 4 logic outputs representing the Vote Indicate, Unsilence Indicate, Code Detect, and Fail Indicate for each channel. The Vote and Fail outputs are also configured so they can be used as inputs to either Force Vote a channel or Disable a channel. These inputs provide a function that is similar, but not identical to, the front panel switch.

2.2.2.4 Each comparator chassis has a Test LED indicator and a Test/Operate switch. Generally the indicator is off when the comparator is operating normally without any faults. If the indicator is on or flashing, some kind of diagnostic or service function is being indicated. The Test switch causes the comparator to go through the power-up diagnostic process. A Unit Reset input is also provided on the 25 pair ribbon connector to do the same function as the Test switch.

2.2.2.5 Each comparator chassis has a Standby indicator LED and a Standby/Operate switch. The Standby switch is wired in parallel to each comparator through the expansion connector, and allows the outputs of the comparator to be switched off. In this way redundant comparators can be connected in parallel with all but one of them switched into standby. The comparator may be switched from standby to operate at any time and then the outputs are switched on.

2.2.2.6 Each comparator chassis has a Coded and a Voted indicator. The Coded indicator shows whether or not the comparator is voting in coded mode or not. All comparators connected through the expansion connector show the same state for the Coded indicator. The Voted indicator shows which chassis has the currently voted channel. Only one chassis can have its Voted indicator turned on at any instant.

2.2.2.7 Each comparator chassis has a Comparator Active output and a Comparator Coded Active output that indicate that the comparator is actively voting on a channel. These are asserted at the same time on each comparator connected to the expansion connector. In addition to the above, there is a Coded Disable input and a Clear Disable input to selectively inhibit either the coded or clear function of the comparator.

2.2.2.8 Each comparator chassis has a Power indicator and a 5 Volt Failure indicator to show the status of the power supply voltages on the chassis.

2.2.3 Other Features

2.2.3.1 The comparator provides two other features of interest to service personnel. The first is a non-volatile memory (NOVRAM), for storage of personality data. The personality data consists of many optional delays, levels, etc, which configure the comparator to a particular application. In this way the comparator avoids reliance on too many jumper and switch options.

2.2.3.2 The comparator also provides a diagnostic port which utilizes a standard RS-232 interface for use with any of numerous terminal devices. With a terminal connected to the diagnostic port, a user may modify the personality and determine the diagnostic status of the comparator.

3. INSTALLATION

The installation of the DIGITAC comparator is reasonably simple. To ease installation requirements, extensive use has been made of 25 pair ribbon connectors similar to standard telephone type connectors. In this way the installation may often be planned in such a way to be as simple as mounting the chassis into a rack and then inserting a few connectors.

3.1 GENERAL

Upon receipt of the equipment, thoroughly inspect the shipping containers and the equipment for any possible damage. Report any damage, and the extent thereof, to the shipping company immediately. Be especially careful if any of the covers have been damaged or removed from the equipment. Generally, the covers are intended to protect the delicate circuits underneath, and their removal may subject the circuits to potentially damaging electro-static discharges, or harmful moisture and dirt.

3.2 PLANNING THE INSTALLATION

Carefully plan the installation before any work is started, as a good installation obtains the best possible performance of the system. Consider the availability of primary power, DC backup power if required, control lines, ventilation, and servicing access before starting the installation. The comparator is intended to operate over a wide temperature range (-30° to +60° C), so special air conditioning or heating is usually not required. The comparator is definitely not intended to operate in a very dusty, dirty, wet, electrically noisy or otherwise hostile environment, as these areas generally cause problems with the electrical signal connections with corresponding performance degradations.

3.3 VENTILATION

The cabinets containing the comparators have vents that allow outside air to be drawn in through an opening at the bottom and expelled through an opening in the top. It is important that the intake and outlet air flow vents are not obstructed. Leave at least 6 inches of free air space on all sides. It is strongly recommended that enough room be left in front of, and behind the comparator to give sufficient access to open the cabinet for servicing.

3.4 CABINET INSTALLATION

The THN6316A 70 inch indoor cabinet has the same physical dimensions and mounting dimensions as those shown for the THN6194B 70 inch indoor cabinet in the attached Station Cabinet Dimensional Details, PEPS-17767. The THN6318A 46-inch cabinet has the same physical dimensions and mounting dimensions as those shown for the THN6143A 46-inch indoor cabinet in the Station Cabinet Dimensional Details section. Refer to the Station Cabinet Dimensions Details for mounting details for the cabinets.

3.5 AUDIO AND CONTROL LINE CONNECTIONS

Refer to the appropriate manual sections (part of this overall manual), for connector locations and input/output connector pin references. Recessed in the rear of the chassis is the external wire hook up area. This area consists of two external 50-pin connector ports (P805 and P806), a dc power input (J800), and a dc fuse holder (F1). The two 50 pin cables for connector ports P805 and P806 may be dressed from either the top or bottom sides of the chassis. Place the cable clips (Motorola Part No. 4206958M02) in the chassis flanges for cable dressing. The dc fuse (F1) is removed by pressing on the lower edge of the fuse holder on top of the word PRESS. The fuse holder is spring loaded and ejects the fuse after pressing. It is necessary that the customer provide line overvoltage protection for all telephone line connections to the comparator to prevent damage to the equipment.

3.5.1 Audio Input Connections

3.5.1.1 The audio inputs to each comparator chassis are made to connector P806. Refer to the attached System Interconnect Diagram (4-SP5253351) for channel/connector pin references, and to the attached Comparator Card Cage Functional Block Diagram (3-SP5253351), for connector locations. Audio inputs may be the audio outputs of receivers, digital/voice modems, or microwave equipment as shown on the System Interconnect Diagram.

3.5.1.2 In an 8 channel system, only one comparator chassis is necessary. In this case, all audio inputs are made to P806 on that chassis. In 16 channel systems, two comparator chassis are necessary. In this case, the channels 9 through 16 are made to the second chassis. If more channels are required, connections for channels 17 thru 25 are made to chassis 3, connections for channels 25 thru 32 are made to chassis 4 and connections 33 thru 40 are made to chassis 5. Regardless of the number of channels the audio connections for each chassis are made to P806 as shown on attached diagram 4-SP5253351. For large systems with more than 8 channels, the audio connections are split into groups of 8 channels and connected to each comparator chassis.

3.5.2 Control Connections

3.5.2.1 Most of the control connections are made to connector P805 on the comparator chassis. The only other control connection is the Console Test Indicate that appears at connector P806 pin 6. Again refer to attached diagram 4-SP5253351 for channel/connector pin references and to the attached Card Cage Connector Location Diagram for connector locations. The control connections consist of control outputs from the comparator, control inputs to the comparator, and bi-directional control lines to and from the comparator.

3.5.2.2 As in the case of the audio connections, separate control connections are necessary for many of the functions on each chassis in applications with more than 8 channels. A notable exception to this is the Standby Request that is connected to all chassis through the expansion connector. Assertion of the Standby Request on any chassis causes it to be asserted on all chassis in a large comparator with more than 8 channels.

3.5.3 Audio Output Connections

There are four audio outputs available from each comparator chassis. Two of the outputs (LINE OUT 1 and LINE OUT 2) are available at connector P805. The other two outputs (LINE OUT 3 and LINE OUT 4) are available at connector P806. Refer to the attached System Interconnect diagram. The outputs are applied to a CIU unit at the control console that passes any clear audio or decrypts any coded audio to the console. The four outputs of each comparator are routed through jumpers J508, J512, J516 and J520 on the Output board to facilitate audio output configuration. These are discussed in more detail in the Output board instruction section in this manual. The configuration of these jumpers determines the function of the four audio output lines.

3.5.4 Expansion Connections

In applications with more than eight channels, it is necessary to daisy chain expansion output P803 and expansion input P804 ports into a continuous ring configuration. Refer to the attached System Interconnect diagram for details. Connect output expansion port P803 of the card cage on the bottom of the cabinet to the input expansion connector P804 of the card cage immediately above it using a short expansion cable. Connect P803 of this card cage to P804 of the card cage immediately above it also using a short expansion cable. Continue in this manner until the input expansion port of the card cage in the top of the cabinet is connected. Next, connect the output expansion port of the top card cage to the input expansion port of the card cage in the bottom of the cabinet using a long expansion cable. This completes the expansion ring connections required.

3.6 JUMPER AND SWITCH SETTINGS

3.6.1 General

There are jumpers on the Output board to connect the voted audio outputs to each of the four line drivers. There are also jumpers intended to either always switch off an output line, or always switch on an output line. There is a jumper on the Input board used to select between Range 1 (used with input test tone levels between 11 dBm and -15 dBm), and Range 2 (used with input test tone levels between 0 dBm and -26 dBm). On the Kernel board, there is a jumper to disable the watchdog timer and also a jumper to force the chassis into the Service Mode. the majority of these jumpers should be set once, and then never changed. In the case of the Input board and Kernel board jumpers, it is strongly recommended that they not be adjusted if at all possible. Whenever boards are removed from the chassis for servicing, there is a small possibility that damage from careless handling can occur. The safest place for the boards is in the chassis. To aid in troubleshooting it is better to rely on the software features described elsewhere.

3.6.2 Output Board Jumpers

3.6.2.1 Jumpers J500 through J507 control the line driver output impedances (they allow either 600 or 900 ohm output impedances to be selected). There are two jumpers for each output line. Note that output impedances of 1650 ohms and high impedance are also selectable. The 1650 ohm case is not recommended for any application and its performance is not specified. The high impedance case is definitely not recommended and does not function reliably. The standard configuration is for 600 ohm output impedance.

OUTPUT IMPEDANCE JUMPERS							
LINE OUT 1	LINE OUT 2	LINE OUT 3	LINE OUT 4	600 OHMS	900 OHMS	1650 OHMS	HIGH
J500	J502	J504	J506	IN	OUT	IN	OUT
J501	J503	J505	J507	IN	IN	OUT	OUT

3.6.2.2 Jumpers J508, J512, J516 and J520 connect the available audio buses to the four available line driver circuits. Only the output bus is currently used and it is the Voted Audio bus. Two optional audio inputs are provided but are not connected to anything. Each line driver has four jumpers to allow for connection to any of the four buses. DO NOT put a shorting jumper in more than one position of a particular jumper, as this will short two or more audio buses together and degrade performance. The standard configuration is to connect at least one of the outputs to the voted audio bus. These functions are shown below.

OUTPUT SELECTOR JUMPERS				
	LINE OUT 1	LINE OUT 2	LINE OUT 3	LINE OUT 4
VOTED AUDIO	J508-A	J512-A	J516-A	J520-A
AUX AUDIO	J508-B	J512-B	J516-B	J520-B
OPT. BUS 1	J508-C	J512-C	J516-C	J520-C
OPT. BUS 2	J508-D	J512-D	J516-D	J520-C

3.6.2.3 Jumpers J524 through J531 control the output relay switches. The jumpers in the J524 to J527 group force relays to always be open, i.e., in standby. The jumpers in the J528 to J531 group force relays to always be closed (as long as power is applied), and will override any jumpers in the J524 to J527 group. When the relays are closed the output lines are active. There is one jumper in each group for each output line. All of these jumpers override the Standby switch on the front panel and the Standby Request input. The standard configuration is to leave all of these jumpers out.

STANDBY JUMPERS				OPERATE JUMPERS		
		NORM	STBY		NORM	OPER
LINE 1	J524	OUT	IN	J528	OUT	IN
LINE 2	J525	OUT	IN	J529	OUT	IN
LINE 3	J526	OUT	IN	J530	OUT	IN
LINE 4	J527	OUT	IN	J531	OUT	IN

3.6.2.4 Input Board Jumpers

Jumpers J100, J200, J300 and J400 control the line input attenuation. They allow either 4 dB attenuation for an input signal range of -26 to 0 dBm, or 15 dB attenuation for an input signal range of -15 to +11 dBm. The standard configuration is for 15 dB input attenuation as shown below.

INPUT ATTENUATION JUMPERS					
INPUT 1	INPUT 2	INPUT 3	INPUT 4	4dB	15dB
J100	J200	J300	J400	OUT	IN

3.6.3 Kernel Board Jumpers

3.6.3.1 There are two Kernel board jumpers. The watchdog defeat jumper is listed as TP2 and should always be out. The watchdog timer prevents the software from accidentally getting "lost". When this happens, the timer should time out and force the microprocessor to reset. If the watchdog defeat jumper is "in", this function is inhibited and the comparator may fail as a result.

3.6.3.2 The service mode jumper is listed as TP1 and should always be out for normal operation. If it is "in" then the software enters the service mode after power-up, and normal comparator functions are not performed. The service mode is necessary to adjust the personality of the comparator. An alternate method of entering the service mode is provided by a software diagnostic function of the diagnostic port. If the service mode is entered by a software request, then it times out after a certain interval if no inputs are detected. This timeout is inhibited if the service jumper is "in". At this time, there is no function of the service jumper that cannot be accessed by means other than inserting the jumper. As a result, it is better to leave the Kernel board in the chassis and not use this jumper.

3.6.4 Switch Settings

3.6.4.1 Located on the interconnect board inside each chassis between the Kernel board and the Peripheral board is an 8 section DIP switch. It is necessary to remove the Kernel board and the Peripheral board from the chassis to gain access to the DIP switch. Power should not be applied to the chassis when the boards are removed. This switch must be properly set on each comparator chassis to assure proper operation of the comparator system. The setting of the DIP switch is different for each chassis. The switch should be oriented vertically with switch number 1 at the top and switch number 8 at the bottom. The switch number references below assume this orientation.

3.6.4.2 The first four switches (labeled 1 through 4) control a number called the module ID for the chassis. These switches are read by the microprocessor during power-up to assign a unique ID to the chassis so that it can identify itself through the expansion connector. Every chassis that is interconnected through the expansion connector must have a different ID selected with these switches. The switches encode a 4 bit binary number. When the switch is open, the corresponding bit is a 1, and when the switch is closed the corresponding bit is a 0. The module ID is printed out the diagnostic port during power-up. For installations with the chassis located in a single rack, it is suggested that the IDs be numbered consecutively starting with 0000 for the top chassis in the rack. The switch settings and corresponding module ID are shown below.

MODULE ID SELECTOR SWITCH SETTINGS

SWITCH 4	SWITCH 3	SWITCH 2	SWITCH 1	I D	SWITCH 4	SWITCH 3	SWITCH 2	SWITCH 1	ID
CLOSED	CLOSED	CLOSED	CLOSED	0000	OPEN	CLOSED	CLOSED	CLOSED	1000
CLOSED	CLOSED	CLOSED	OPEN	0001	OPEN	CLOSED	CLOSED	OPEN	1001
CLOSED	CLOSED	OPEN	CLOSED	0010	OPEN	CLOSED	OPEN	CLOSED	1010
CLOSED	CLOSED	OPEN	OPEN	0011	OPEN	CLOSED	OPEN	OPEN	1011
CLOSED	OPEN	CLOSED	CLOSED	0100	OPEN	OPEN	CLOSED	CLOSED	1100
CLOSED	OPEN	CLOSED	OPEN	0101	OPEN	OPEN	CLOSED	OPEN	1101
CLOSED	OPEN	OPEN	CLOSED	0110	OPEN	OPEN	OPEN	CLOSED	1110
CLOSED	OPEN	OPEN	OPEN	0111	OPEN	OPEN	OPEN	OPEN	1111

3.6.4.3 The next two switches (labeled 5 and 6) control the bit rate for the diagnostic serial port connector on the Kernel Board. Bit rates of 300, 1200, 2400 and 9600 bps are selectable as shown below. The standard bit rate is 9600 bps, but lower bit rates may be desirable for low speed terminal equipment.

DIAGNOSTIC PORT BIT RATE SETTINGS

SWITCH 6	SWITCH 5	BIT RATE
CLOSED	CLOSED	9600
CLOSED	OPEN	2400
OPEN	CLOSED	1200
OPEN	OPEN	300

3.6.4.4 The last two switches (labeled 7 and 8), are not assigned any function. To help ensure compatibility with future versions of the software, it is recommended that both switches be left closed. In this way if software features should be designed to take advantage of these switches, then the software can use the closed state as a benign state to be compatible with previous versions of the hardware.

3.7 CIRCUIT BOARD LOCATIONS IN THE COMPARATOR CHASSIS

3.7.1 Refer to the attached Comparator chassis interconnect board diagram (in attached section 10S-SP5253351) for details. There are five operational boards and three blank panels on the comparator chassis. When facing the front of the chassis these boards are, from left to right, two blank panels, one Output board, two Input boards, one Kernel board, one Peripheral board and one blank panel. The two Input boards contain controls and status displays for each of the input channels. The Input board (which is toward the left side of the chassis) contains control and status for input channel 1 (at the top of the board), through input channel 4 (at the bottom of the board). The Input board at the right contains status and control information for input channel 5 (at the top of the

board), through input channel 8 (at the bottom of the board). Make certain the boards are located in their appropriate positions.

3.7.2 In some installations it is possible that 4 or fewer channels are required for the chassis. In this case only one of the Input boards is required. The second Input board (on the right for channels 5 through 8), can be optionally removed in these circumstances. If the first Input board is removed, the software generates an error and causes the Test LED to flash. In addition, an error message is printed out the diagnostic port.

3.7.3 It is obvious that the Kernel and Peripheral boards are mandatory for proper comparator operation. What is less obvious is the requirement for the Output board. The Output board provides audio paths for looback testing during power-up as well as the audio gating functions for voting in the clear mode. As a result, if the Output board is missing, the software generates an error and flashes the Test LED.

3.8 POWER CONNECTIONS

3.8.1 The comparator chassis may be powered directly by a 13.8 V dc power supply. In cases with battery backup, this is a convenient dc voltage to achieve with any of several kinds of lead-acid batteries. The typical current drain is 2.1 Amps and the specified power supply voltage is 13.8 V dc $\pm 20\%$. The chassis is designed to operate from a negative ground supply. Positive ground systems are not recommended to power *DIGITAC* comparators.

3.8.2 A good ground for the chassis is highly recommended for a reliable installation. This provides some measure of electro-static and transient protection because it allows the comparator to discharge the harmful voltages to ground through the chassis. If the chassis is not grounded, transients can be discharged through the power supply and may or may not cause problems.

3.8.3 Several comparator chassis may be powered by a TPN1239A ac power supply. In this case, the power supply requires 120 V ac primary power at 4.2 Amps for each cabinet, regardless of the number of channels in each cabinet. The primary power lines should be installed in accordance with local electrical codes. Connect the ac line cord from each comparator power supply into a primary power ac outlet. The comparator begins the power-up diagnostic routine immediately upon application of ac primary power. The ac power is converted to 13.8 V dc by the power supply which is used to supply each comparator chassis. The purpose of the diagnostic routine is to determine if the unit is operating properly and, if not, to isolate the faulty circuitry from the system to prevent interference with other functioning circuitry. The power-up diagnostics require approximately 20 seconds to execute.

3.8.4 The Test LED on the Kernel board lights continuously while the power-up diagnostics are executing. During power-up testing, all the front panel LEDs except the power supply LEDs on the Peripheral board and the Standby LED on the Output board, are forced on so that malfunctioning LEDs can be located and repaired.

3.8.5 Note that if any of the boards are to be removed or added to the comparator the power should be turned off. This precaution avoids any transients that can damage the comparator circuits. It is not necessary to disconnect an unpowered comparator from the chassis that are powered up. If service is required on a single chassis, and it is desired to keep other chassis in a multiple chassis system operating, it is possible to disconnect 13.8 V dc from the back of the chassis with the dc power connector. It is also possible to disconnect the fuse on the chassis though this is more cumbersome.

3.9 PERSONALITY SETTINGS

3.9.1 General

3.9.1.1 To set up the personality for a comparator chassis it is necessary to have the comparator operating. The comparator must execute all power-up diagnostics successfully. If the Test LED turns off, the power-up diagnostics were successful. If the Test LED flashes after power-up, then something is wrong but the power-up was probably successful. If the Test LED is on continuously, something is wrong and the personality cannot be set.

3.9.1.2 It is necessary to interface a terminal to the diagnostic serial port on the Kernel board in order to print out and edit the personality settings. The speed of the serial port is selectable with the DIP switch on the motherboard on the chassis as described previously. The port is a standard RS-232 interface that is set for 8 bits/character, 1 stop bit, and no parity.

3.9.1.3 During the power-up diagnostics, a message like the one shown below should print out. Some variation in the message format is normal. Notably the number of consecutive periods will vary depending on the vagaries of the power-up transient. If any faults are detected during power-up, they are also printed out in this message.

SAMPLE POWER-UP MESSAGE

```
SECURENET DIGITAC COMPARATOR
RECEIVE SOFTWARE VERSION 1.00
COPYRIGHT MOTOROLA INC. 1986, 1987
```

```
Performing self-tests
```

```
. . . . .
. . . . .
. . . . .
```

```
Module ID: 1000 Two Input Boards present
```

```
All tests passed.
Self test complete
```

3.9.2 Printing Out the Current Personality

3.9.2.1 At this point the comparator should be operating normally and the personality will either be the last personality stored in a non-volatile memory, or a default personality that is used if the non-volatile memory was missing, faulty, blank, or otherwise unusable. Commands to view the personality and change it are available and are entered by typing in single letters or numbers. The software contains a command interpreter that reads in the letter and immediately echoes it back to the terminal. The interpreter then responds in some way. To view all of the available commands simply type H or ? for help. The software works for upper or lower case characters equally well so it is not necessary to always use upper case. The result of the H command is something like the following.

H Command

Useful commands:

C Clear diagnostics
H or ? Help
L test LED reason
S Service mode
X expansion status

F hardware Faults
K coded diagnostics
P Personality print
W Why channel failed
+ power supply

Other commands:

1-8 channel table

A Alignment table
D Delay table
I inversion mask
R status tone Ratio
U DUART faults
Y signal zero values
. special help

! change expansion state
B voting status
E Expansion table
M Module table
T Time count
V software Version
Z noise zero values

3.9.2.2 The explanation for all of these commands is done elsewhere. For now only the P and the S command are required. To view the current personality settings type the letter P. The result is similar to the following print out.

```
P Command
Personality device status = blank
MEMO:
DATE:
GENERAL:
Line failure time (sec)      1      2      3      4      5      6      7      8
Activity threshold (dBm0)   -14   -14   -14   -14   -14   -14   -14   -14
Disable requests (Y/N)      N      N      N      N      N      N      N      N
Output status tone enables: primary = Y      aux = Y

CLEAR: (times are in msec, hysteresis is in dB)
Settle time = 150      Hold time = 850      Sample period = 0
Mute time   = 150      Hysteresis = 2      Clear disable = N

CODED: (times are in msec, disable is Y/N)
Code detect time = 30      Code dropout time = 60
Diff. input delay = 128      Additional delay = 0
Voting buffer pad = 39      Output buffer pad = 40
Coded disable    = N

SERIAL I/O:
New line ASCII characters = <CR><LF>      Line length = 64
Delays (msec): character = 4      Line = 0
```

The first line after the P gives the current status of the non-volatile memory. If it is anything but “good”, the software uses the default personality settings that are displayed here. In this case the non-volatile memory was “blank” so the default settings are used and displayed here.

There are two lines labeled MEMO and DATE. These are general purpose lines stored in the personality for use by field personnel. They have no assigned function in the software and can be set in any way that is useful. The suggested usage is to set the MEMO to some kind of information about the personality such as the person who last adjusted it. The DATE could be used to set the date when the personality was set. The default settings are blank. There are up to 31 characters allowed in the MEMO and up to 9 characters allowed in the DATE.

There are four main categories of personality settings that are briefly called GENERAL, CLEAR, CODED, and SERIAL I/O. The GENERAL category covers settings that are not dependant on either the clear or coded modes of operation. The CLEAR and CODED categories cover special settings that only apply to corresponding clear or coded messages. The SERIAL I/O category covers settings to modify the diagnostic serial port printouts.

3.9.3 General Personality Settings

3.9.3.1 The first two lines of the GENERAL category are the line failure time and the activity threshold. These control the activity time-out for each of the 8 input lines for this chassis. The purpose of the activity timer is to detect the presence of a broken input line, and disable that line so it will be nearly silent. An activity detector determines whether or not an input channel is silent by comparing the input level with a threshold level. If the level is exceeded, then the line is not silent and it does not fail. If the level is below the threshold, then the line is “silent”, and a timer begins. If the expires before the level exceeds the threshold, the channel is designated as failed, and it is disabled from voting. To control this process, an activity level and a timer duration need to be specified.

3.9.3.2 The default activity detector settings (shown in the P command print out), are for a -14 dBm0 threshold and a 60 second timeout. Another common timeout is 15 seconds. To prevent activity detector timeouts a very low threshold must be used; value less than -100 dBm0 is sufficient.

3.9.3.3 The next line in the GENERAL category is the disable requests. These are Yes or No values that either causes a channel to be permanently disabled or not. The defaults are No, which leaves all channels enabled. If any of the channels are never to be used, and it is desired to always disable them, the value for that channel can be set to Yes. Note that channels are never enabled until they detect the presence of status tone; so the disable request values need to be adjusted for proper comparator operation if the unused channels are not connected. If a channel has a disable request asserted in the personality, even the presence of status tone will not enable it.

3.9.3.4 The last line in the GENERAL category is the output status tone enable. There are two switches to enable status tone on either the primary or the auxiliary voted audio bus. In some applications status tone is used on the comparator voted audio to signify the idle periods between messages. In these applications the status tone must be enabled. In other applications, status tone is not used and so the status tone should not be enabled (i.e. the value should be No).

3.9.4 Clear Personality Settings

3.9.4.1 There are six settings in the CLEAR category. The first four are the setting time, hold time, sample period, and mute time. These times control the vote lock feature in the clear mode. The setting time is how long the software waits for the vote to settle before it locks the vote to any given channel. The hold time is how long the software waits after the settling time before the vote is allowed to unlock the change. The sample period is how long the software waits between vote samples after the vote hold time has expired. The default values for these parameters are set up to lock the vote for 850 msec. after a 150 msec. setting time. This is compatible with most systems that use MDC-600™ signaling.

3.9.4.2 The mute time controls a mute function at the beginning of clear messages. The mute prevents clear audio from getting through the comparator and going out the voted audio path. During the mute time the internal voting processes and timers are active but the output is inhibited. The mute is useful for systems with digital voice modems where a training sequence may take place in the clear mode before the coded message begins. The default time of 150 msec. is compatible with the current Motorola Digital Voice Modem.

3.9.4.3 The hysteresis value controls the amount of hysteresis used in the voting algorithm. In the clear mode, the comparator measures the amount of noise present in the audio signal. It initially votes the signal with the lowest noise level. After the first vote, the comparator does not let the vote change until the noise on another channel is better than the noise on the voted channel (a margin that is set by the hysteresis). The standard value of hysteresis is 2 dB. A value of 0 dB turns off the hysteresis. This is not recommended for systems with large numbers of channels because the vote may flicker between several channels and slightly degrade the voted audio output.

3.9.4.4 The last setting is the clear disable value. If this is Yes, then the clear mode is disabled and the comparator will not vote in the clear mode. In some cases this may be useful, but it is not generally used. The default setting is No.

3.9.5 Coded Personality Settings

3.9.5.1 There are seven settings in the CODED category. The first two time settings are intended to describe the time it takes for the code detector to respond in the comparator once valid code is present (or absent) on the line input. The next two are delay settings to control the internal coded voting delays. The next two are pad settings which directly affect the efficiency of the internal coded voting algorithms. The coded disable value is analogous to the clear disable value in the CLEAR category.

3.9.5.2 The code detect time is intended to represent the typical time delay between when a coded signal is present on the line input and when the code detector actually responds with a code detect. Because the software continuously stores all the information that comes in through the line input, the software can retrieve information that came in shortly before the code detect actually occurs. As a result, the software does not have to discard any information that occurs at the beginning of a message. The code dropout time is the analogous delay at the end of the coded message. It tells the software how many bits to discard when the code detect drops out. The default values of 30 msec. and 60 msec. are the best values for the code detector used in the DIGITAC comparator.

3.9.5.3 The differential input delay is the amount of delay the comparator uses to enable it to compare bits from differential channels. Because the comparator has only a finite memory, it cannot arbitrarily delay the inputs for comparison purposes. This delay parameter describes how much difference there may be between the signals on the line inputs. A default value of 128 msec. is used to handle the difference possible when one input line uses a digital voice modem (with a long delay), and another input has a satellite receiver directly connected (for no delay).

3.9.5.4 The additional delay is used to control an internal delay that is added before any bits can come out of the voted output. It is useful in systems where it is desirable to delay the signal to allow other events to happen so that no bits at the beginning of a message are lost. Typically this might be used in synchronous encryption systems (where a preamble is transmitted at the beginning of the message), and it is very undesirable to truncate any of the starting bits because of the risk of losing the preamble. A value of 0 msec. is the default because delays have undesirable effects also. Therefore many systems may not require any delay.

3.9.5.6 The coded disable value is set to Yes if the coded mode is to be disabled. When the coded mode is disabled, there is never any coded output of the comparator. This may have value in systems that operate only in the clear mode. Obviously, it is not sensible to have both the coded mode and clear mode disabled.

3.9.6 Serial I/O Personality Settings

3.9.6.1 There are four settings in the SERIAL I/O category. These affect the diagnostic port and are useful to control the output for devices that are non-standard or very slow. The first setting is the sequence of characters that are used to begin a new line. Usually they are <CR><LF> which represents a carriage return character (ASCII value \$0D) and a line feed character (ASCII value \$0A). In some cases a different sequence may be more useful. The next setting controls the width of the printout. Current software does not utilize this value.

3.9.6.2 The last two settings are the character and line delays. These control how long the software waits after a character is transmitted out of the serial port before it transmits the next character. For slow printers or terminals, it may be desirable to slow the printing by setting these delay parameters a little higher than the defaults. The line delay is how long the software waits after starting a new line before it transmits the first character of the new line.

3.9.7 Adjusting the Personality

3.9.7.1 To change the personality settings, it is necessary to enter the service mode. This is easily done with the S command. When the S command is used, the response should be as shown below. The service mode does not support any of the processes that perform the voting tasks during the normal mode of operation. As a result, the service mode should only be entered when the comparator is not actually running a radio system. The software guards against accidental service mode entry by querying with a short message. Any response other than Yes does not result in entry into the service mode.

```
S      Command
Do you wish to enter service mode? (y/n)--> y
Now in service mode.      Type H or ? for help.
```

3.9.7.2 Once the service mode is entered a short prompt message is printed out to indicate that the service mode is active and the Test LED begins to flash rapidly. In the service mode there are multiple levels for the commands and the initial level is at the top. To display the top level commands, simply type H or ? and the following message will appear.

```
H      Command
Service mode commands are:
      H or ?  help
      P personality editing
      Q quit service mode
```

3.9.7.3 To change the personality settings, simply type P. This enters a lower level for commands specialized to personality editing. These commands may be displayed by typing the H or ? command.

```
P Command
Now editing the personality.
H
Personality editing commands are:
C clear
D date
E exit personality editing
F fetch defaults
G general
H or ? help
I serial I/O
K coded
M memo
P print
Q quit service mode
R read from nonvolatile storage
T test
W write to nonvolatile storage
```

3.9.7.4 At this point it is useful to understand the personality storage device. It is called a non-volatile RAM or NOVRAM for short. It is designed so that it can retain its memory contents even after power is shut off. It has a significant limitation in that the non-volatile storage can only be written into relatively slowly and only for a finite number of times. Fortunately the write operation can be performed thousands of time, which is more than enough if the writes are carefully controlled. Mainly, because of this limitation, the software does not write to the NOVRAM unless the user tells it to. The command to do this is the W command.

3.9.7.5 To generally use and change the personality, a separate copy is stored in the regular memory. This storage is volatile so any power interruptions while the editing process is underway will destroy the memory but not the NOVRAM data. The contents of the copy may be initialized to the defaults with the F command. The copy can also be copied from the NOVRAM itself with the R command. When the service mode is first entered, the copy is whatever was created by the power-up diagnostics (which will be either the defaults or the actual NOVRAM contents).

3.9.7.6 The current contents of the copy may be printed or displayed with the P command exactly the same way that the personality was viewed after power-up above. The result of the P command is shown again below.

```
P Command
Personality device status = blank
MEMO:
DATE:
GENERAL:
Line failure time (sec)      1      2      3      4      5      6      7      8
Activity threshold (dBm0) -14    -14    -14    -14    -14    -14    -14    -14
Disable requests (Y/N)      N      N      N      N      N      N      N      N
Output status tone enables: primary = Y      aux = Y

CLEAR: (times are in msec, hysteresis is in dB)
Settle time = 150      Hold time = 850      Sample period = 0
Mute time   = 150      Hysteresis = 2      Clear disable = N

CODED: (times are in msec, disable is Y/N)
Code detect time = 30      Code dropout time = 60
Diff. input delay = 128    Additional delay = 0
Voting buffer pad = 39     Output buffer pad = 40
Coded disable    = N

SERIAL I/O:
New line ASCII characters = <CR><LF>      Line length = 64
Delays (msec): character = 4      Line = 0
```

3.9.7.7 To edit the MEMO field of the personality, the M command is used as follows. The memo is entered by typing in a single line of characters followed by a carriage return. If a mistake is made, then simply repeat the M command until the memo is as desired. The DATE field of the personality is handled in the same way. Examples of these operations are shown below.

```
M Command
The current memo is:
Type in the new memo followed by <return>.
John Doe's DIGITAC
D
The current date is:
Type in the new date followed by <return>.
87/06/12
```

3.9.8 Editing General Personality Settings

3.9.8.1 To change the GENERAL personality settings type the G command. A typical response is shown on the next page. In general, the comparator steps through each of the values in the category one by one. For each value, it first prints out the current value. The user is then allowed to type any value that is desired. Once the user types a <return>, the comparator processes the value and either accepts, modifies, or rejects the value. In any case, the software prints out the new value, which may be the same as the old value if there is no change. If the user makes a mistake or types an unexpected, or illegal character, the comparator rejects the input and makes no change to the current value.

3.9.8.2 The line failure times show an example where the user did not wish to modify the current personality value from channels 1 through 4. To do so, a <return> was typed (which does not show on the print out below), after the comparator printed out the current 60 second value. As a result, the comparator simply retained the old 60 second value. For channels 5 through 8 however, it was desirable to change the 60 second value to 15 seconds, so the user typed 15 followed by a <return>. The comparator responded by accepting the 15 second value and printing out the new 15 second value.

3.9.8.3 In the case of the activity thresholds, the user wished to turn off the activity timer for channel 8. To do so, a value of -100 dBm0 (but it can represent -103 dBm0), so the comparator rounded the input to a nearby value.

3.9.8.4 In the case of the status tone enables, the user wished to disable status tone on the outputs. To do so the user simply types in a No with the N character. As shown in the example, the comparator responded with the new value which is now N.

```
G Command
General purpose parameters:
To accept current value:      type <return>
To change: type desired value then <return>
Line failure times (sec):
 1  60          60
 2  60          60
 3  60          60
 4  60          60
 5  60   15     15
 6  60   15     15
 7  60   15     15
 8  60   15     15
Activity thresholds (dBm0):
 1  -14         -14
 2  -14         -14
 3  -14         -14
 4  -14         -14
 5  -14   -20    -20
 6  -14   -20    -20
 7  -14   -20    -20
 8  -14  -100   -103
```

```

Disable requests (Y/N):
  1  N  N
  2  N  N
  3  N  N
  4  N  N
  5  N  N
  6  N  N
  7  N  N
  8  N  N
Status tone enabled on primary audio bus (Y/N) = Y  n  N
Status tone enabled on aux audio bus (Y/N)      = Y  n  N
Finished.

```

3.9.9 Editing Clear Personality Settings

3.9.9.1 To change the clear category of settings use the C command. The method for the clear parameters is very similar to the method used for the general parameters above. the comparator steps through the values one by one giving the user the opportunity to change each one. In the following case, the user only modified the hold time by lengthening it to 1500 msec., and the sample period by lengthening it to 200 msec. For the time parameters the legal values are in the range of 0 to 59999 msec. Values in the range of 60000 to 65535 msec. are special and tell the software to hold the time off forever. These values should only be used for the hold time when a permanent vote lock is desired. An example follows:

```

C Command
Clear mode parameters:
To accept current values:      type <return>
To change: type desired value then <return>
Settle time (msec)      = 150      150
Hold time (msec)        = 850      1500      1500
Sample period (msec)    = 0        200        200
Mute time (msec)        = 150      150
Hysteresis (dB)         = 2        2
Clear disable (Y/N)     = N        N
Finished.

```

3.9.10 Editing Coded Personality Settings

3.9.10.1 To change the CODED category of settings use the K command (mnemonic would be Koded). The method of changing the coded parameters follows the conventions for the clear settings with some interesting exceptions. Nearly all of the coded parameters are time values and they add up in a strange way to produce a net throughput delay which is computed and printed out after all of the delay parameters have been entered. The comparator has a maximum internal buffer size that it can use for the delay. Consequently, if any of the time values exceed some buffer size limitations, or if the resulting total delay exceeds the allowed buffer size then the entire set of values is discarded. In this event an error message is printed out describing the out of range values.

3.9.10.2 To edit the two buffer pad sizes, a Yes reply is necessary for the query: "Do you want to edit the buffer pad sizes?" If the response is Yes, then the comparator prompts the user with the current sizes and allows the user to modify the buffer pad sizes. The total throughput delay is computed after the buffer pad sizes are entered so that they too are checked against the internal range limits. Changes to the buffer pad sizes are not recommended.

3.9.10.3 The final parameter edited by the user is the coded disable value. If this value is Yes, then coded mode is inhibited for the comparator. If the value is No, the comparator may operate in the coded mode.

3.9.10.4 In the following example, the user modified the differential input delay and the additional delay parameters. Notice that the resulting total throughput delay is now 313 msec. All of the other parameters have been left unchanged.

```
K Command
Private (coded) mode parameters:
To accept current value:      type <return>
To change: type desired value then <return>
All values are in msec.
Code detect time (nom)   = 30      30
Code dropout time (nom) = 60      60
Max input delay diffrnc = 128    150    150
Additional delay (nom)  = 0      50     50
Do you want to edit the buffer pad sizes? (y/n) = > n
Resulting coded throughput delay (nom) = 313
Coded disable (Y/N)     = N      N
Finished
```

3.9.11 Editing Serial I/O Personality Settings

3.9.11.1 The SERIAL I/O category is edited with the I command. An example is shown below. The new line characters are the characters that the comparator prints out when a new line is to be printed. The usual sequence is a carriage return followed by a line feed. The user has the choice of selecting either just a carriage return, or just a line feed by typing in a 1 or a 2. In the example, just a <return> was typed so no change was made.

3.9.11.2 The delays between characters and between lines control how long the comparator waits before attempting to transmit the next character. The wait is timed from the beginning of the character and not from the end. There are about 10 bits of information that are transmitted for each character. As a result, times shorter than $1/10 \times 9600 = 1$ msec have no effect for 9600 bps. Times shorter than $1/10 \times 300 = 33$ msec have no effect for 300 bps. The delay between lines may be extended to fairly large values to help control very slow printing devices.

```
I Command
Serial I/O parameters:

To accept current value:      type <return>
To change: type desired value then <return>
New line characters = <CR><LF>
Type 0: <CR><LF>; 1: <CR>; 2: <LF> --> <CR><LF>
Line length = 64      64
Delay (msec) between characters = 4      40      40
Delay (msec) between lines = 0      100     100
Finished.
```

3.9.12 Write to Nonvolatile Memory

To save the new information in the nonvolatile memory use the W command. The response should be as shown below. The user may now type Q to quit the service mode and restart. An alternative is to type E to exit the personality editing function, and begin some other service function. When the comparator is restarted it reads the information out of the nonvolatile memory and runs with the new personality settings.

```
W Command
RAM image now saved in the personality device.
Q
Quitting the service mode.
```

3.10 AUDIO LEVEL ADJUSTMENTS

The audio levels to be adjusted can be subdivided into audio inputs and audio outputs. The comparator has an AGC circuit on the inputs to allow considerable flexibility on the allowed input levels. There are potentiometer adjustments for the audio outputs.

3.10.1 Audio Input Level Adjustment

3.10.1.1 The audio input levels must be set correctly for proper operation of the comparator. There are no audio input level adjustments on the comparator itself since the AGC circuit on the input board keeps all of the input levels constant from channel to channel. Since there are a variety of input devices that may be used with the comparator, i.e. satellite receivers, microwave receivers, telephone lines, etc., refer to the appropriate instructions for the input device to adjust the input line level and status tone level.

3.10.1.2 The input audio test tone level may be set between -26 dBm and +11 dBm in two ranges, -26 dBm to 0 dBm, or -15 dBm to +11 dBm. See section 3.6.2.4, Input Board Jumpers for details. The input status tone level must be set 13 dB below the audio test tone level, i.e. the level must be -13 dBm. This makes the allowed input status tone level range -39 dBm to -2 dBm. The suggested input levels are 0 dBm for test tone and -13 dBm for status tone.

3.10.2 Audio Output Level Adjustment

The comparator output consists of voted audio whenever the system is active and status tone or silence whenever the system is idle. The output audio level of audio test tone is adjustable between -26 dBm and +11 dBm. Status tone is at an output level 13 dB below the audio test tone level (-39 dBm to -2 dBm). Set these levels as follows.

Step 1. Make certain the device the comparator is driving is connected to the output lines before setting the audio output levels. This ensures proper line loading.

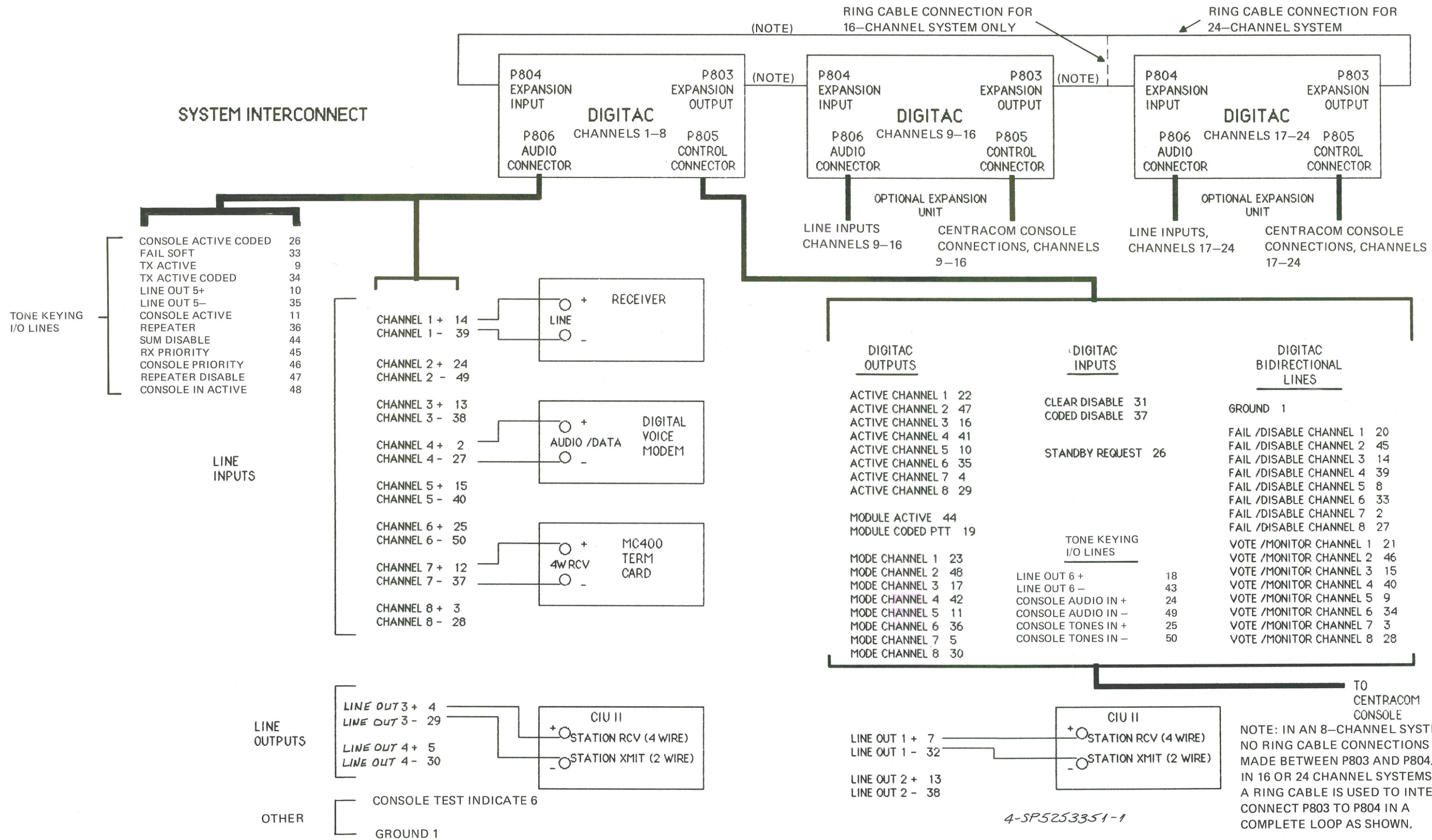
Step 2. Connect a bridging ac voltmeter across the line output that is to be adjusted. Bridging the voltmeter avoids loading the line. If the output status tone has been enabled, perform Step 3A; otherwise perform Step 3B.

Step 3A. Disable all input channels by placing all the Monitor/Normal/Disable switches on the Input boards to the Disable position. The Fail LEDs on the Input boards should be solidly lit. This forces the comparator to output status tone.

Step 3B. Input status tone to at least one of the input channels. Switch the Monitor/Normal/Disable switch to the Normal position. The status tone should be detected and the Fail indicator should go out in a few seconds. All other indicators on the channel should also be extinguished. the channel should now have a status tone detect on the channel, and the AGC should now be stable and locked onto the status tone. Now switch the Monitor/Normal/Disable switch to Monitor. This outputs the status tone to the voted audio output.

Step 4. Locate the LD Level Adj potentiometer that corresponds to the line output to be adjusted on the front panel of the Output board. Adjust this potentiometer for system status tone output level (suggested -13 dBm) as read on the ac voltmeter connected in Step 2.

Step 5. Repeat Step 4 for each output channel used in the system. Return all the Monitor/Normal/Disable switches for all the active channels on the Input boards to the Normal position.



4-SP5253351-1

NOTE: IN AN 8-CHANNEL SYSTEM, NO RING CABLE CONNECTIONS ARE MADE BETWEEN P803 AND P804. IN 16 OR 24 CHANNEL SYSTEMS, A RING CABLE IS USED TO INTERCONNECT P803 TO P804 IN A COMPLETE LOOP AS SHOWN.

THN6141A Cabinet (31-Inch) Indoor

THN6142A Cabinet (41-Inch) Indoor

THN6243A Cabinet (60-Inch) Indoor

THN6143A Cabinet (46-Inch) Outdoor

parts list

THN6141A Cabinet Kit (30-Inch) PL-1787-F

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
non-referenced items		
15-84107D25	CABINET (30")	
13-84430D01	DOOR VENT (8 required)	
2-10101A55	SPEED NUT (48 required)	
1-80730D78	COVER, cabinet entry	
2-10101A73	NUT, speed; 36 used	
3-1930	SCREW, machine: 4-40 x 3/8"	
3-7542	SCREW, tapping: 8-15 x 3/8"; 2 used	
42-10217A02	STRAP, tie; 2 used	
64-84884M01	PLATE, slide	
64-84885M01	PLATE, mounting	

THN6142A Cabinet Kit (41-Inch) PL-1790-C

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
non-referenced items		
15-84143D24	CABINET (41")	
13-84430D01	DOOR VENT (8 required)	
2-10101A55	SPEED NUT (48 required)	
1-80730D78	COVER, cabinet entry	
2-10101A73	NUT, speed; 36 used	
3-1930	SCREW, machine: 4-40 x 3/8"	
3-7542	SCREW, tapping: 8-15 x 3/8"; 2 used	
42-10217A02	STRAP, tie; 2 used	
64-84884M01	PLATE, slide	
64-84885M01	PLATE, mounting	

THN6243A Cabinet Kit (60-Inch) PL-3401-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
non-referenced items		
15-83445K04	CABINET (60-Inch)	
13-84430D01	DOOR VENT (8 required)	
2-10101A55	SPEED NUT (48 required)	
1-80730D78	COVER, cabinet entry	
2-10101A73	NUT, speed; 36 used	
3-1930	SCREW, machine: 4-40 x 3/8"	
3-7542	SCREW, tapping: 8-15 x 3/8"; 2 used	
42-10217A02	STRAP, tie; 2 used	
64-84884M01	PLATE, slide	
64-84885M01	PLATE, mounting	

STATION HARDWARE KITS

TRN6197A (12-Watt, 1-Receiver) PL-3397-B
TRN6198A (12-Watt, 2-Receiver)
TRN6199A (Hi-Power, 1-Receiver)
TRN6200A (Hi-Power, 2-Receiver)

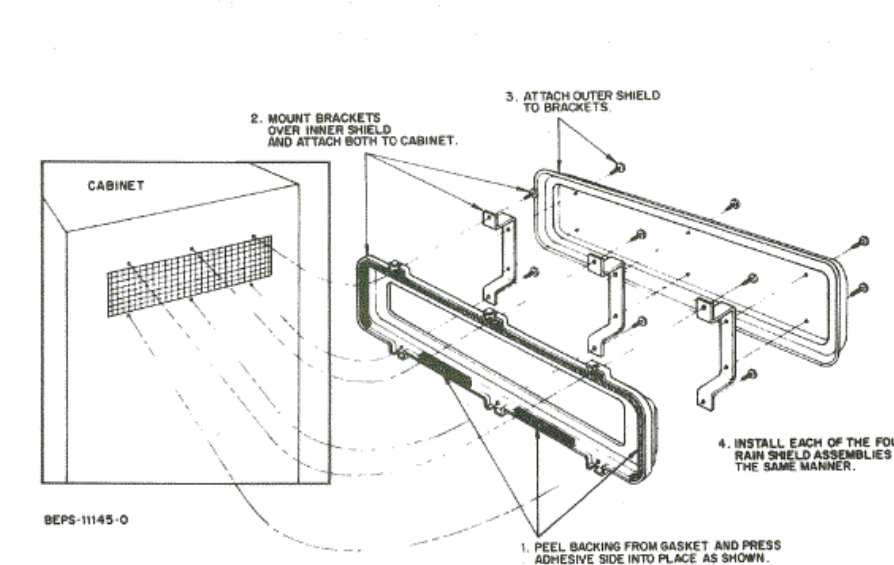
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
1-80731B73	SHIELD, exciter board	
1-80734B45	SHIELD, power control board	
1-80734B44	SHIELD, receiver filter board	
1-80728B57	SHIELD, audio board	
64-82623K02	COVER, plate (used in hi-power stations)	
1-80775B78	BRACKET ASSY., includes	
7-82298K01	BRACKET (used in 12-watt stations)	
55-84300B01	BRACKET (used in hi-power stations)	
55-84300B02	HANDLE, plastic	
2-84410P04	HANDLE, plastic	
3-135038	SPEEDNUT, special	
42-83629G01	SCREW, tapping: 1/4"-14 x 3/4"	
2-10101A53	PIN, accordion	
46-84090C01	NUT, spring	
3-13945	STUD, retainer	
33-83051K01	SCREW, tapping: 6-20 x 5/16"; 5 req'd.	
5-83855G01	NAMEPLATE	
13-813618	RIVET, "pop"	
54-842366	LABEL (patent)	
54-850440	LABEL (replacement parts)	
54-83040C01	LABEL (FCC license designation)	
65-105515	LABEL (exciter audio)	
42-10217A10	WRENCH, "Allen"	
	"Tywrap"	

TLN4862A Outdoor Vent Kit PL-1797-A

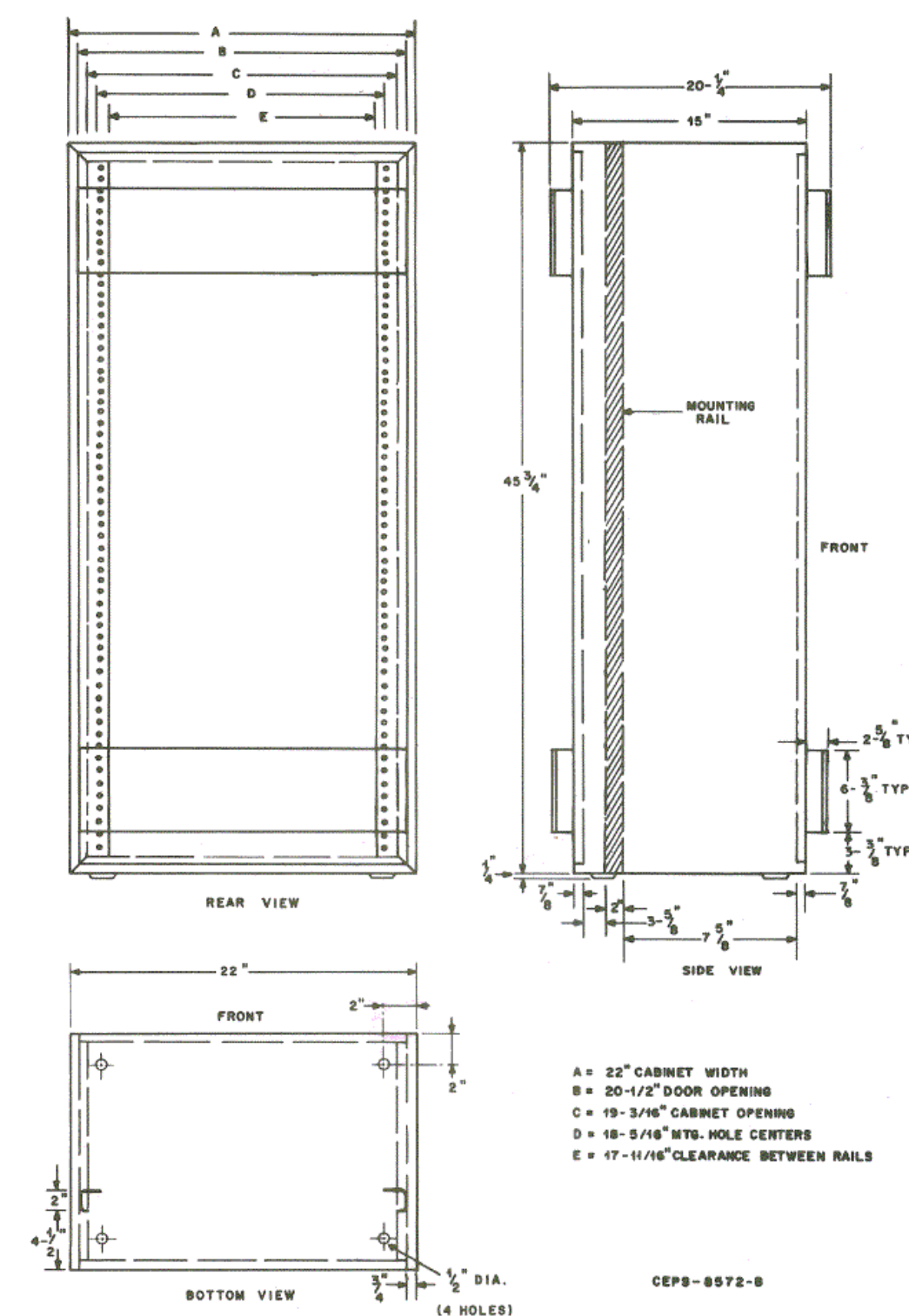
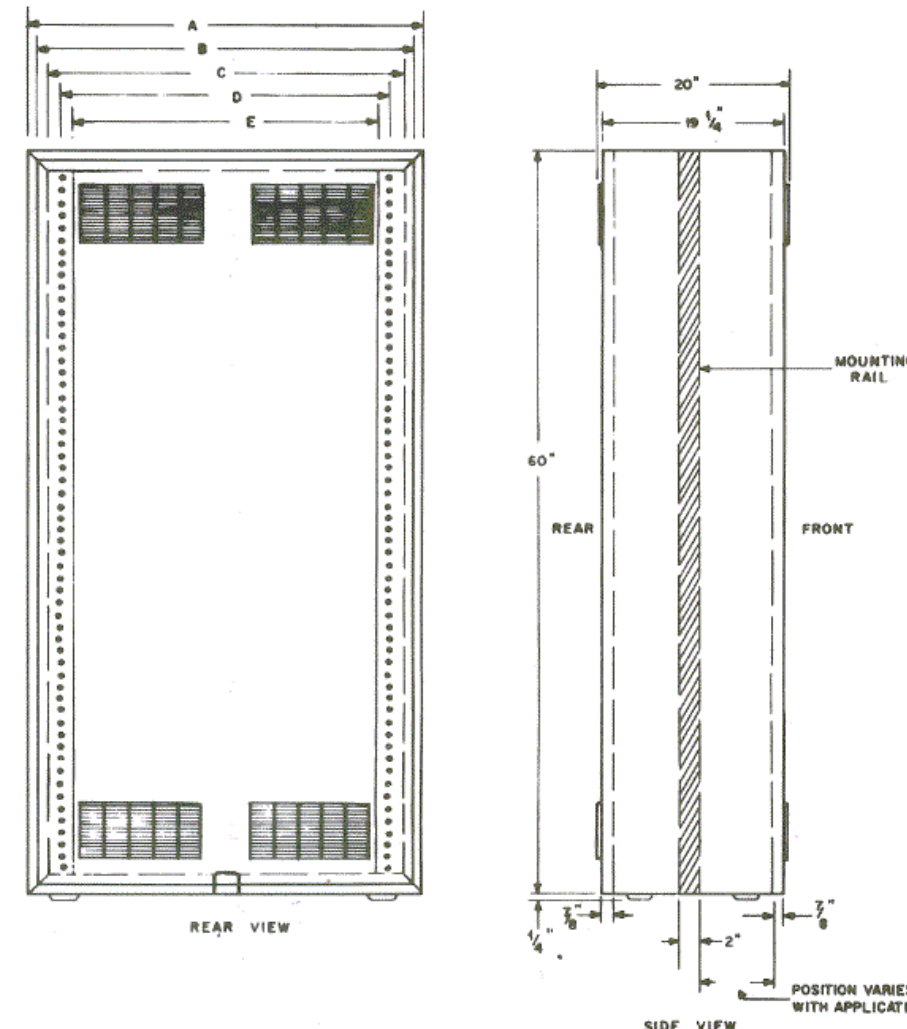
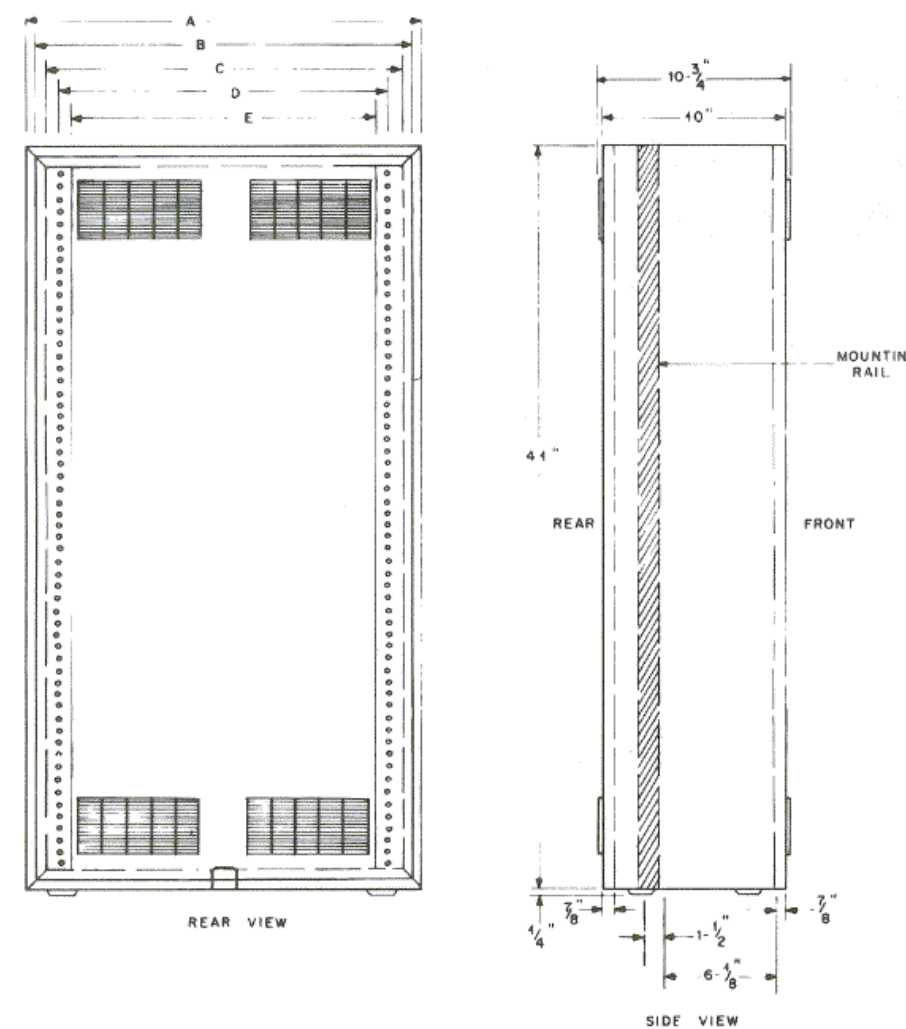
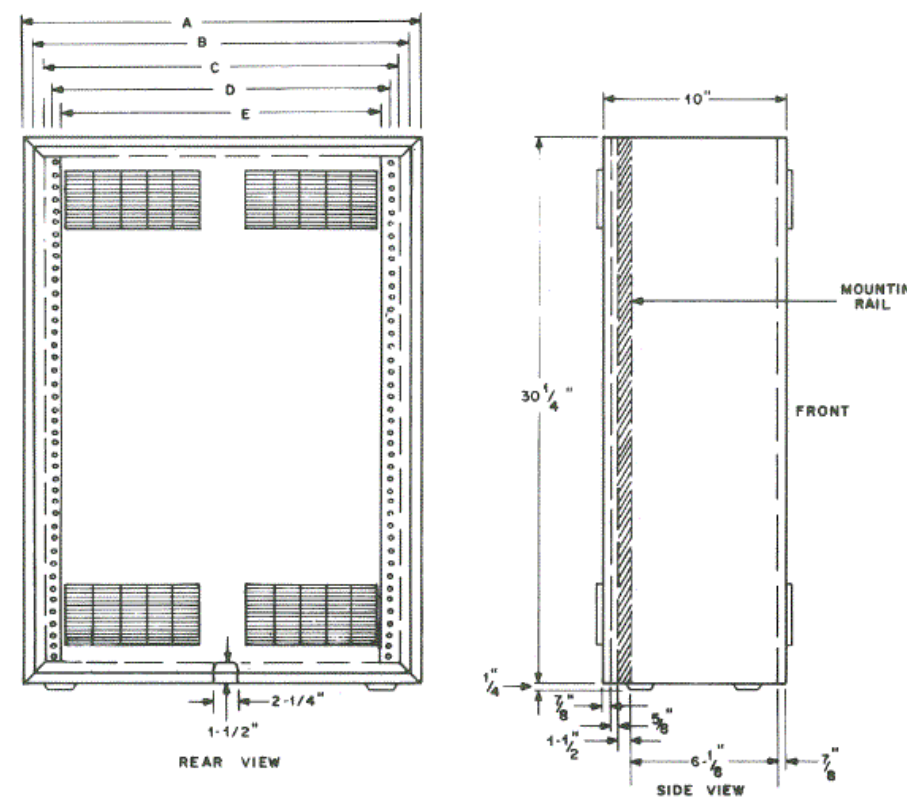
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
15-84188D01	COVER, outdoor vent (No. 1); 4 req'd.	
15-84189D01	COVER, outdoor vent (No. 2); 4 req'd.	
32-84452D01	GASKET; 4 req'd.	
32-84452D02	GASKET; 8 req'd.	
7-84187D01	BRACKET, vent cover; 12 req'd.	
4-490775	FLATWASHER; 24 req'd.	
4-9795	LOCKWASHER; 24 req'd.	
3-133674	SCREW, machine: 6-32 x 11/16"; 24 req'd.	
3-138209	SCREW, tapping: 6-32 x 3/8"; 24 req'd.	
2-7005	NUT, hex: 6-32 x 1/4"; 24 req'd.	

NOTE: Except where noted, differences in models are in quantity of parts only.

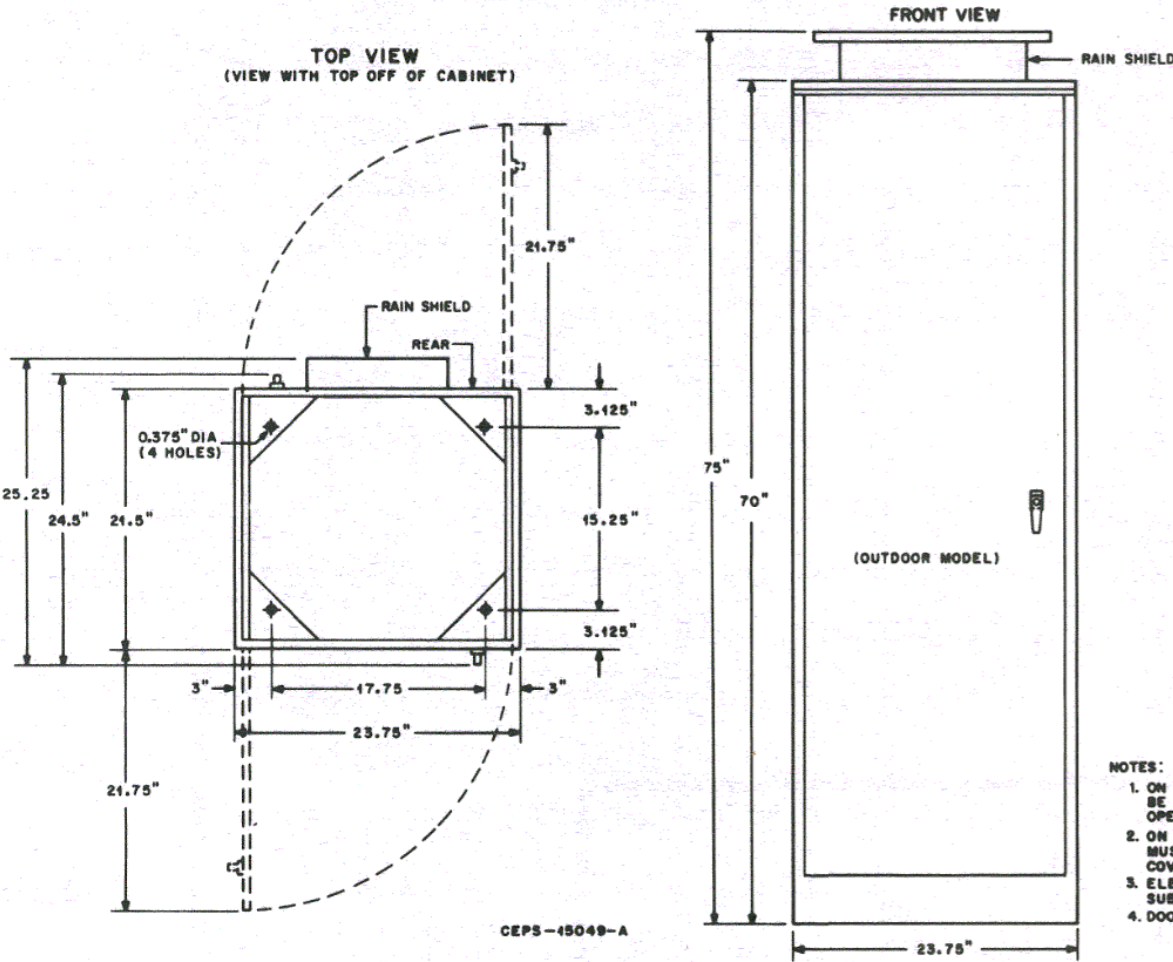
Outdoor Vent Kit



Station Cabinets
Dimensional Details and Parts Lists
Motorola No. PEPS-17767-E
(Sheet 1 of 2)
9/10/87-UP

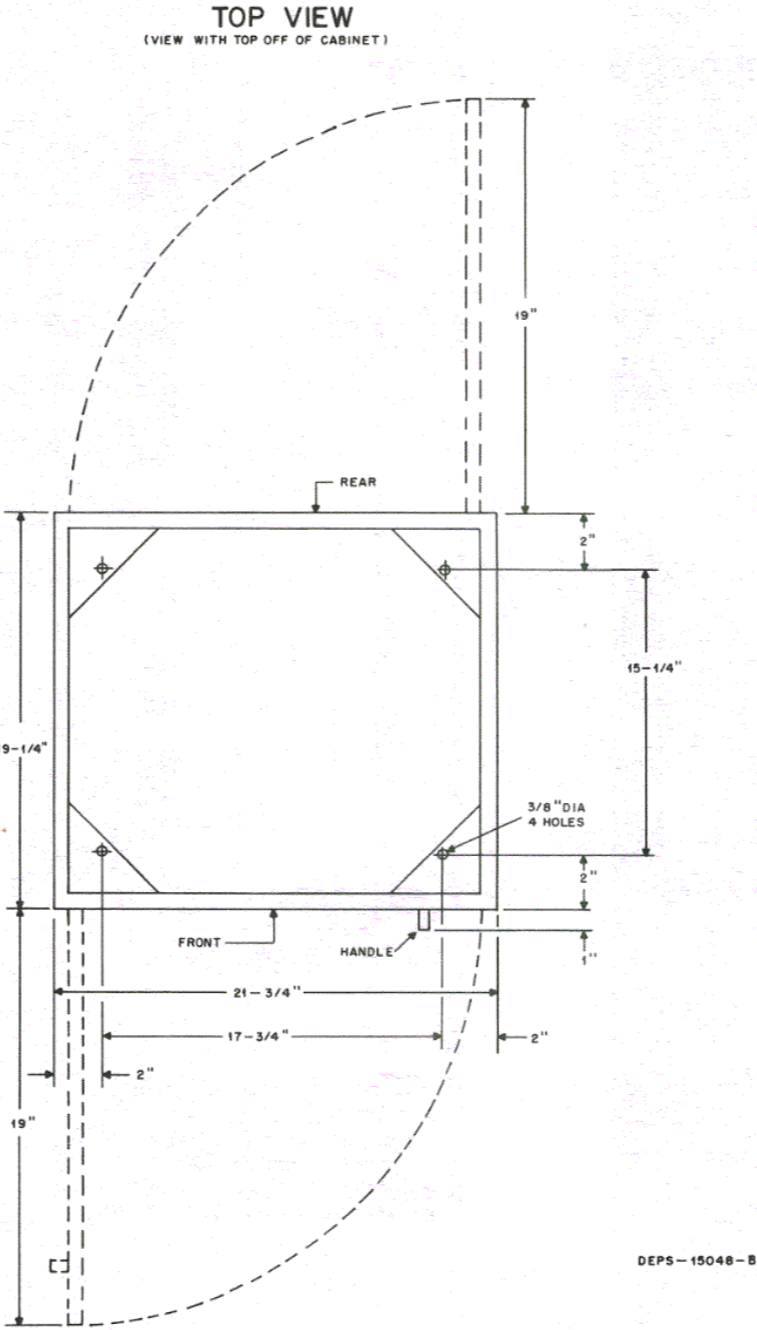


TMN6203A Cabinet (75-Inch) Outdoor



- NOTES:
1. ON INDOOR CABINETS, FRONT AND REAR DOORS CAN BE REVERSED FROM RIGHT OPENING TO LEFT HAND OPENING.
 2. ON REAR DOOR, OPENING OPPOSITE AIR DUCT MUST BE UNCOVERED AND UNUSED OPENING COVERED (INDOOR CABINETS ONLY).
 3. ELEVATE CABINET IF DANGER OF WATER SUBMERSION EXISTS.
 4. DOORS ON OUTDOOR CABINETS ARE NOT REMOVABLE.

TMN6194B Cabinet (70-Inch) Indoor



- NOTES:
1. FRONT AND REAR DOORS CAN BE REVERSED FROM RIGHT HAND OPENING TO LEFT HAND OPENING.
 2. ON REAR DOOR, UPPER AIR DUCT OPENING MUST BE UNCOVERED AND BOTTOM AIR DUCT OPENING COVERED.
 3. ELEVATE CABINET IF DANGER OF WATER SUBMERSION EXISTS.

parts list

TRN6190A Cabinet Hardware Kit (70" and 75") PL-3396-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
2-836540		NUT, speed; 2 req'd.
3-839590		SCREW, special (washerhead); 2 req'd.
2-84410P04		NUT, speed: 1/4"-14; 4 req'd.
3-135038		SCREW, tapping: 1/4"-14 x 3/4"; 4 req'd.
3-115727		SCREW, machine: 10-32 x 1/2"; 2 req'd.
4-7652		LOCKWASHER: No. 10; 2 req'd.
37-107997		GROMMET; 2 req'd.
33-82830H02		LOGO ("MOTOROLA")

TLN6892A Rain Shield Kit PL-3402-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
26-82929H01		SHIELD, rain (top)
26-84084F01		SHIELD, cover (top)
15-82926H01		COVER, rain shield
26-82930H01		SHIELD, rain (door)
32-82930H01		GASKET, rain shield
32-82932H02		GASKET, rain shield
32-84180G01		GASKET, 2 req'd.
32-84180G02		GASKET, 2 req'd.
2-10080A03		NUT, spring: No. 8; 4 req'd.
3-9661		SCREW, machine: 8-32 x 3/8"; 8 req'd.
3-132823		SCREW, tapping: 8-18 x 3/8"; 4 req'd.
3-135014		SCREW, tapping: 8-18 x 1/2"; 6 req'd.



OPERATING INSTRUCTIONS

MODEL Q2980A THROUGH Q2989A

DIGITAC™ COMPARATOR

1. GENERAL

1.1 This section discusses operation of comparator controls and indicators during normal operation of the comparator. The main set of controls and indicators are those on the chassis that may be used to give the comparator operational status, and which may be used to some extent for testing. The diagnostic port on the Kernel board provides a serial RS-232 port for more informative diagnostics.

1.2 All operating controls and indicators for the DIGITAC comparator are located on the front panels of the Output board, 2 Input boards, the Kernel board, and the Peripheral board. When facing the front of the DIGITAC comparator chassis, the board locations are as follows, from left to right: 2 blank panels, (the two blank panels are replaced with a QRN4515A Transmitter Control board in the far left position and a QRN4516B transmitter Audio board in the position to the right of that if tone keying is desired. See the tone keying module instruction section 5S-SP5253351 in this manual for front panel controls on these boards.); Output board, Input board 1 (for channels 1 through 4), Input board 2 (for channels 5 through 8), Kernel board, Peripheral board, and 1 blank panel. On the Input boards, the controls for channel 1 or for channel 5 are located at the top of the board, and the controls for channel 4 or for channel 8 are located at the bottom of the board.

2. OUTPUT BOARD CONTROLS AND INDICATORS

The Output board has a Standby/Normal switch and a Standby Indicator. The only other control from the front panel of the Output board is the Line Output level adjustment, and that is discussed in the Installation Section (50S-SP5253351) of this manual (paragraph 3.10.2).

2.1 STANDBY/NORMAL SWITCH

The Standby/Normal switch is used to manually switch the comparator out of the normal active mode and into the standby mode. On comparator units that are connected through the expansion connector, any of the Standby/Normal switches may switch the chassis into standby. In standby, the line outputs are switched off (unless they are jumpered otherwise) so that another comparator in the normal mode may output voted audio to the lines. In the normal mode, the outputs are switched on (unless they are jumpered otherwise). This allows two comparators to operate independently of each other with one of them used as a hot standby. Note that the Standby/Normal modes do not affect any other aspect of the comparator operation.

2.2 STANDBY LED INDICATOR

The Standby indicator on the front of the Output board indicates whether the module is in the standby or normal mode of operation. The LED is lit whenever the standby mode is selected.

3. INPUT BOARD CONTROLS AND INDICATORS

The Input board controls and indicators are duplicated for each input channel. The controls and indicators for each channel are independent of the other channels. The normal idle state for the switches is in the central position, while the indicators should all be turned off. Turning the switch on any channel up or down usually causes an indicator to turn on for that channel.

3.1 MONITOR/NORMAL/DISABLE SWITCH

3.1.1 Each of the four input channels on an Input board has a Monitor/Normal/Disable switch. Setting the switch in the Monitor position causes the comparator to select the associated channel as the voted channel; route the audio from the channel through the voted audio path; and cause the Vote LED indicator for the channel to light. This is the monitor function and is intended to allow service personnel to directly monitor the audio on an input channel, even if it is idle or failed. If more than one channel has the monitor function asserted, then the lowest numbered channel is selected for monitoring. Note that this function is not quite analogous to voting a channel because it switches the audio onto the output (even if it is idle and the audio is status tone).

3.1.2 Placing the switch in the Disable position causes the comparator to disable the associated channel, disregarding any inputs to the channel. This causes the Fail LED indicator for the channel to light solidly. This is slightly different from a channel failure because the comparator diagnostic software takes no action to raise an alarm or make any kind of diagnostic message. Failed channels are treated differently from disabled channels in other ways as well so service personnel should recognize the difference.

3.1.3 Placing the switch in the Normal position causes the comparator to resume normal operation on the associated channel. If the channel is the voted channel the Voted LED lights. If the channel is idle, i.e. it has status tone, then all the indicators for the channel extinguish.

3.2 UNSQUELCHED LED INDICATOR

This indicator signals activity on the channel that the comparator considers to be valid and available for a vote. There are several conditions that prevent just any signal from being considered valid. First, if the channel has status tone, then it is idle and the indicator is off. Also, if the channel is failed or disabled, then it is not considered as available for voting and the Unsquelled indicator is turned off. Typical channel failures are caused by the detection of internal faults on the channel by the diagnostics, or by the activity detector timeout in the clear mode. A channel can be disabled by the Monitor/Normal/Disable switch.

3.3 CODE DETECT LED INDICATOR

This indicator signals coded activity on the channel. As in the case of the Unsquelled indicator, it may be forced off if the channel is idle, failed, or disabled. The indicator turns on when a 12 kbps random (uncorrelated) signal is detected, or when EOM (6 kHz or 3 kHz) is detected.

3.4 VOTED LED INDICATOR

3.4.1 This indicator is lit on the channel that is currently being voted. In the case of the clear mode this indicator means that the audio for the channel has the best quality (i.e. lowest noise), and it is gated to the voted audio output. In the case of the coded mode this indicator shows the channel with the lowest bit error rate. In some circumstances this is the coded signal that comes out the voted audio output. In other circumstances, the comparator majority votes the signals from several channels and constructs a voted output, which is better than the input on the channel with the lowest bit error rate.

3.4.2 This indicator may also be lit when a channel is being monitored or force voted. The monitor function is asserted with the Monitor/Normal/Disable switch. The force vote function is asserted with the external inputs for each channel and it usually comes from a control console. In these cases the indicator shows which channel is currently selected rather than voted.

3.5 FAIL LED INDICATOR

3.5.1 This indicator flashes on channels that are failed. Failures are usually caused by a timeout of the activity detector, in which case the fault is probably external to the comparator. Failures may also be caused by diagnosed hardware failures inside the comparator, in which case this indicator flashes, and so will the Test LED Indicator on the Kernel board. Generally a flashing indicator means that something is wrong and requires attention by service personnel.

3.5.2 This indication turns on continuously when the channel is disabled. This may be caused by a disable request from the personality settings, the front panel Monitor/Normal/Disable switch, or the channel may be disabled with an external console control. The disable function indicates that the channel is inhibited from voting but that nothing is wrong with it.

4. KERNEL BOARD CONTROLS AND INDICATORS

4.1 TEST/OPERATE SWITCH

The test/operate switch causes the microprocessor on the Kernel board to be reset when it is placed in the TEST position. In this state, the microprocessor is halted and the comparator is “frozen”. This only affects the chassis with the Kernel board. It does not have any effect on chassis that are connected to the expansion connector except for the fact that voting information no longer flows through the chassis. When the Test/Operate switch is moved to the OPERATE position, the comparator executes the power-up diagnostic routines, and then begins normal operation. This switch is the simplest way to find out the diagnostic “health” of the comparator chassis because it causes the comparator to restart and forget any of the information it currently has.

4.2 TEST LED INDICATOR

4.2.1 The Test LED indicator provides an indication of the module status. The LED may be on continuously, flashing, or off, depending on the status of the chassis. Generally, the desired operating state is with the Test indicator off. When the indicator is on continuously, there is probably some kind of massive comparator failure. If the LED is flashing, some kind of intermediate status between fully functional and a massive failure is indicated.

4.2.2 If the TEST indicator is lighted continuously, the comparator is being held in the Test state. This may come about if the Test/Operate switch is switched to the Test position. It may also be caused by a serious error during the power-up diagnostic routines in which case the software never completes the power-up routines to turn off the indicator. In this case, the comparator attempts to print out a diagnostic message through the diagnostic port on the Kernel board to indicate the nature of the serious failure. It is normal for the Test indicator to stay on continuously for about 20 seconds while the power-up routines are executing. While the routines are running, they flash the Coded and Voted indicators to give some kind of a progress indication.

4.2.3 There are two types of flashes the Test indicator can make to indicate the presence of a non-serious fault. A double flash consists of a 150 msec on, 150 msec off, 150 msec on, 550 msec off sequence. A single flash consists of a 200 msec on, 800 msec off sequence. The double flash indicates a more severe fault than the single flash. A double flashing Test indicator means that the microprocessor is functioning but that some kind of fault has been detected to prevent any voting from taking place. The comparator is not fully functional if the Test indicator is double flashing.

4.2.4 A single flash of the Test indicator means that a relatively simple fault has been detected by the diagnostics. An example would be a failure of the status tone detector hardware on any input channel. If the fault is localized to the hardware for a specific channel, that channel is failed, and its Fail indicator will also be flashing. The cause of a flashing Test indicator may be found with some interrogative commands through the diagnostic port. Generally a single flash means that full operation is impaired but partial operation is still possible.

4.3 CODED LED INDICATOR

4.3.1 The Coded indicator turns on whenever the output of the comparator is in the coded mode. For this to happen, at least one of the input channels should be in the coded mode. This may be inhibited if the coded mode is disabled, either from the personality or with one of the console inputs. In cases where multiple comparator chassis are connected together through the expansion connector, the coded information is shared between them. When one chassis is coded, all will be.

4.3.2 During the power-up diagnostics this indicator flashes to indicate the progress of the power-up routines. It is normal for the flashing to be irregular as this indicates that the software is waiting for various signals to settle out of any power-up transients that have been induced by the power-up routines.

4.4 VOTED LED INDICATOR

The Voted indicator turns on whenever there is an output signal from the comparator chassis. This means that the voting process has selected an output signal and gated it to the output audio lines. In cases where multiple chassis are connected together through the expansion connector, only one Voted indicator is lit at a time, and it indicates the chassis with the currently voted channel. As in the case of the Coded indicator, the Voted indicator flashes during the power-up sequence.

5. PERIPHERAL BOARD INDICATORS

The Peripheral board indicators are predominantly power supply indicators. In cases where the Test indicator on the Kernel board shows a serious fault, the Peripheral board gives the indication of the power supply status.

5.1 POWER LED INDICATOR

The Power indicator is lit whenever 13.8 V dc power is applied to the chassis. This indicator turns off if the dc fuse fails. This indicator does not show the status of the lower voltage supplies that are derived from the main 13.8 V dc power.

5.2 5 V FAIL LED INDICATOR

The 5 V fail indicator shows the status of the 5 volt power supply. If this supply fails the Fail indicator turns on and typically means that the chassis is completely dead.

5.3 LOW VOLTAGE LED INDICATOR

The Low Voltage indicator lights whenever the dc input voltage to the comparator fails below 10 volts.

5.4 EXPANSION LED INDICATOR

5.4.1 The expansion indicator displays the expansion status of the particular chassis of the comparator. ON indicates that this chassis is the "Master". OFF indicates that this chassis is a "Slave".

5.4.2 For 8-channel comparators, this indicator should be ON. For expanded comparators (more than 8 channels) the indicator should be ON in only one chassis. It should be OFF in all other chassis.

6. DIAGNOSTICS

6.1 GENERAL

The diagnostic software for the *Digitac* Comparator can be divided into two parts. The first part executes only during power-up and provides a confidence test of the comparator hardware. The second part executes during normal operation of the comparator and continuously monitors the status of several internal devices and values to see if anything detectable has failed. While the two parts are mostly separate, there are a few cases where the functions overlap and perform identically.

6.1.1 Power-up Diagnostics

6.1.1.1 The power-up diagnostics information provided to the user is intended to describe the progress of the power-up sequence. During the power-up sequence the comparator flashes the Coded and Voted indicators on the Kernel board. If these do not flash, something catastrophic has occurred in the sequence and the comparator probably will not be able to even print out a message to indicate the nature of the fault.

6.1.1.2 One of the earliest actions of the power-up sequence is to print out the software version number and copyright notice in a format similar to the sample power-up test shown below. If these items do not print out and the Coded and Voted indicators flash at least once, the serial port is not set up for the correct bit rate or another kind of malfunction of the serial port exists.

6.1.1.3 After the comparator prints out the "Performing self-tests" line it begins executing several tests. the progress of those tests is indicated with the print out of the consecutive decimal points. Since some of the tests require that power-up transients settle out, the time duration of the tests can vary from comparator to comparator. If a serious error occurs during these tests, an error message is printed out such as "ROM version numbers do not agree!" In this case the comparator terminates the power-up sequence after the error message and attempts to restart. The possible serious errors that may be encountered during power-up are generally confined to RAM memory errors, ROM checksum and version errors, expansion DUART errors, and interrupt errors.

```
SAMPLE POWER-UP TEST
=====
SECURENET DIGITAC COMPARATOR
RECEIVE SOFTWARE VERSION 1.00
COPYRIGHT MOTOROLA INC.   1986,   1987
ALL RIGHTS RESERVED

Performing self-test
.....
Module ID:  1000  Two Input Boards present

*** CLEAR MODE CHANNEL FAULTS ***
Channel 6 has a clear mode fault.
Channel 8 has a clear mode fault.

Self-test complete
```

6.1.1.4 After the power-up testing is completed, the comparator prints out a few status messages to indicate the module ID, board complement, and any detected non-serious faults. The module ID is printed in a binary format where each bit corresponds to one of the DIP switches on the motherboard. The module ID must be different for each chassis that is connected together with the expansion connector; otherwise, the comparator will generate an error during the normal mode of execution. See the Installation section in this manual for a description of how to set the DIP switch.

6.1.1.5 The standard board complement includes at least one Output board, Input board, Kernel board, and Peripheral board. If there is not one of each, then an error message is printed out after power-up. Also, if only a single Input board is present, then it must be Input board 1 (the leftmost for channels 1 through 4), or an error message will result.

6.1.1.6 Following the board complement the faults are printed out. There are several hardware devices that are separately tested and the results are printed out after power-up. These devices may also be accessed during the normal run-time. These devices are tabulated below. In addition, each channel undergoes several tests that are designed to provide calibration data for the A/D converters as well as a check on the various detectors for each channel. If these fail, an error message prints out very much like the one above (which indicates that channels 6 and 8 have problems with the clear mode circuitry). In these cases, the noise levels on those channels are high enough to affect the channel's performance, so the software has failed those channels.

TESTED HARDWARE DEVICES AND THEIR LOCATION

DEVICE	LOCATION	PURPOSE
SSDA 1	P-board U720	Receives data for channel 1
SSDA 2	P-board U721	Receives data for channel 2
SSDA 3	P-board U722	Receives data for channel 3
SSDA 4	P-board U723	Receives data for channel 4
SSDA 5	P-board U724	Receives data for channel 5
SSDA 6	P-board U725	Receives data for channel 6
SSDA 7	P-board U726	Receives data for channel 7
SSDA 8	P-board U727	Receives data for channel 8
PIA 1	P-board U730	
PIA 2	P-board U731	Status Tone Detects
PIA 3	P-board U732	DVP Unsquench
PIA 4	K-board U47	AGC Enables and RCV DVP
PIA 5	K-board U49	A/D Converters and Board Presence
LED Driver 1	O-board U502	Vote/Monitor and Fail/Disable
LED Driver 2	O-board U503	Activity and Mode Indicators
LED Driver 3	O-board U515	Audio Gating Controls
LED Driver 4	I-board 1 U902	I-board LEDs
LED Driver 5	I-board 2 U902	I-board LEDs
Shift Register 1	I-board 1 U903	I-board Switches
Shift Register 2	I-board 2 U903	I-board Switches
Shift Register 3	O-board U500	Vote/Monitor Inputs
Shift Register 4	O-board U501	Fail/Disable Inputs
DUART 1	K-board U52	Expansion Port
DUART 2	K-board U53	Diagnostic Port
A-D Converter 1	I-board 1 U904	Input Levels
A-D Converter 2	I-board 2 U904	Input Levels
PTM	P-board U734	12 kHz clock, status tone

6.2 NORMAL RUN-TIME DIAGNOSTICS

6.2.1 After the normal run-time mode has been entered, the comparator attempts to manage the channel inputs and vote on the best input given, and any line failures or disables that may be asserted at any given time. If the Test indicator on the Kernel board should start flashing in the normal mode, some kind of service action may be appropriate. To determine the correct action, there are several commands that may be used on the run-time diagnostics to ascertain the nature of the failure.

6.2.2 To view the various commands that are accessible from the diagnostic serial port, type either the H or the ? command. The result is as shown below. The commands that are valuable to determine the nature of a fault are the F, L, W, and X Commands.

H Commands

Useful Commands:

C	Clear Diagnostics	F	hardware Faults
H	or ? Help	K	coded diagnostics
L	test LED reason	P	Personality print
S	Service mode	W	Why channel failed
X	expansion status	+	power supply

Other Commands

1-8	channel table	!	change expn. state
A	Alignment table	B	voting status
D	Delay table	E	Expansion table
I	Inversion mask	M	Module table
R	status tone Ratio	T	Time count
U	DUART faults	V	software Version
Y	signal zero values	Z	noise zero values
.	special help		

6.2.3 To determine why the Test indicator is flashing, type the L command. The result may take several seconds to print out and consists of a single line roughly as shown below. Because the possible faults print out on a single line the information is likely to be cryptic. Some help is accessible by typing the period "." command. This prints out help that depends on the previous command so it is useful for solving some of the more cryptic commands.

6.2.4 The L command prints out 3 pieces of information; hexadecimal values representing causes of minor single flash faults, major double flash faults, and a time count value. If the Test indicator is flashing with a single flash, only the minor faults will have a non-zero value. If the indicator is giving a double flash indication, the major faults will be non-zero. The time value is a hexadecimal value representing the time of the last change in the Test indicator values. the time value represents the value of a 32 bit counter that is incremented every millisecond by an interrupt service routine. The time value starts a 0 immediately after power-up. If the time value is small (like the 2EAC value shown below), the fault was detected shortly after startup and probably indicates a definite failure that was indicated during the power-up sequence. If the time value is large (greater than 10000), the fault is probably only evident after more than 1 minute of running.

L Command

LED faults: Minor > 0001 0000 Major > 0000 0000 Time = 00002EAC

Common LED faults

0001 0000	=	hardware or channel fault
0000 0008	=	AGC gain error

6.2.5 The field definitions for minor and major faults are currently identical. During operation if a fault is detected, 1 of the 32 bits in the fault values is set. This makes it possible to sift through the value to determine the reason for the fault. the 2 most common faults are hardware or channel faults, and AGC device faults. If an AGC is determined to be faulty, the minor fault will be 8 as shown in the help message. If a channel shows a fault (a failed A/D converter for instance), the minor value takes on a value of 10000. It is possible to show multiple faults. If both an AGC and a channel fault occurred, then the minor value would be 10008.

6.2.6 If the L command shows either a channel or hardware fault, there are two commands to try to determine the nature of the fault. the first is the F command which prints out the fault indications for the hardware devices listed above. The F command displays a message similar to the one below. Each hardware device has a single bit, which is cleared to a 0 if no fault is detected, and is set to a 1 if a fault has been found. The sample message below does not show any detected hardware faults. With many of the devices, the nature of a fault may be something else besides a simple failure of the integrated circuit itself. For example, the SSDAs will show faults if the receive clock is absent. This signal comes from the Input boards and it drives the SSDA integrated circuit on the Peripheral board. As a result, something as simple as a broken foil on the motherboard could show up as a fault indicated on an SSDA. The F command merely gives an indicator to tell service personnel where to look next for a problem rather than specifying exactly which integrated circuit is bad.

F Command

HDWR	1	2	3	4	5	6	7	8
SSDA	0	0	0	0	0	0	0	0
PIA	0	0	0	0	0	0		
LED Dr	0	0	0	0	0			
Sh Reg	0	0	0	0				
DUART	0	0						
A/D	0	0						
PTM	0							

6.2.7 The W command displays the status of the channel faults. An example of the command is shown below. Again, a 0 indicates no fault while a 1 indicates a detected fault. In the case shown below channel 6 has a problem with the audio levels while channel 8 has a more massive failure involving everything except the status tone detector.

6.2.8 The “levels” line of the W command generally indicates that too much noise was present on the audio to permit proper calibration. It may also mean that the power-up transients were abnormally large and long such that the software could not wait long enough for them to settle out. In either case, there is a problem on the indicated channel. Since all 4 channels on a single Input board share a common A/D converter, an indicator of a bad A/D converter would be a cluster of level faults on either channels 1 through 4, or 5 through 8.

6.2.9 The “status tone” line gives an indication of a fault with the status tone on a signal that was not status tone, or it failed to detect the actual presence of status tone. This is easily checked manually by service personnel. Another possible cause of this fault is a problem with the PTM that sources the status tone used to check this function.

6.2.10 The “data path” line indicates that good data could not be read through the bit recovery/SSDA path. Possible causes of this problem are malfunctions in the SSDA connections or a problem with the bit recovery circuit. In extreme examples channel noise may get severe enough to affect the data path as well as the A/D calibration.

6.2.11 The “code detect” line indicates whether or not the RCV *DVP* and *DVP* Unsquench signals were properly responding. A failure here could be a missing connection to the PIA that reads the signal or a fault in the coded detector circuit. In this case the noise on channel 8 was severe enough to degrade the code detect signals as well.

W Command

Channels	1	2	3	4	5	6	7	8
Levels	0	0	0	0	0	1	0	1
Stat Tone	0	0	0	0	0	0	0	0
Data path	0	0	0	0	0	0	0	1
Code det	0	0	0	0	0	0	0	1

6.2.12 The last diagnostic command aid is the X command. An example of this command is printed below. This command displays the status of the expansion port in a brief single line format. Additional help for the command is available by typing the period "." immediately after the X. The X command displays whether or not the chassis is the master or a slave on the expansion port. A master makes the final voting decisions for all the chassis. A slave has a simpler role of merely reporting to the master the best available channel that it knows about. Any chassis can be a master.

6.2.13 The X command also displays the number of local and global channels. These are available channels that are not failed. Note that disabled channels count as local channels as well as idle, coded, or clear channels. The local channels are those that are available on the local chassis. It may vary from 0 to 8. Global channels are the sum of all local channels. It can vary from 0 to 64.

6.2.14 The next field in the status is the "ring complete" bit. This bit is set to a 1 when all expansion cables are connected into a ring, and all the chassis in the ring are operational. The ring complete field is set to a 0 when a break in the ring exists. This is not a serious error, but it does indicate a fault with the expansion port somewhere.

6.2.15 The chassis value shows how many DIGITAC chassis are connected in the ring. This number can vary from 1 to 8. The TID value shows the module ID of the current master of the ring. This ID is in the same binary format as the displayed value in the power-up report. The TIME value is the 32 bit time count value that exists the last time any of these values changed. This gives an indication of the frequency with which the expansion status is changing. Frequent changes can be disruptive and indicate problems. Infrequent changes might result from channels that are failing on individual chassis, which would change the global channels count.

6.2.16 The ERR value shows how many checksum errors have accumulated since the comparator began running. This value varies from 0 to 65535. It may increment in normal operation if a chassis is powered up or down in the middle of a message that is transmitted over the ring. Such an event can garble some of the message and cause data to be lost. If the ERR value is incrementing regularly, then something intermittent is probably wrong and requires service.

X Command

```
M    L=0    G=0    R=0    C=1    TID=1000    TIME = 0000 0322    ERR=0
```

.

Expansion status fields

M/S/C	Master/Slave/Configure	
L = local ch.	G = global ch.	R = ring complete
C = chassis	TID = master ID	ERR = errors



DIGITAC™ COMPARATOR CHASSIS

MODEL QCN1218A

1. ATTACHMENTS

-- QCN1218A Comparator Chassis Troubleshooting Chart (sheet 1)	8-SP5253351-1
-- QCN1218A Comparator Chassis Troubleshooting Chart (sheet 2)	8-SP5253351-2
-- QCN6127B Comparator Chassis Parts List	11PL-SP5253351
-- QKN4024A Comparator Chassis Internal Cable Parts List	17PL-SP5252359
-- QRN4542A Comparator Chassis Interconnect Charts	2-SP5253351-1
-- QRN4542A Comparator Chassis Interconnect Charts	2-SP5253351-2
-- QRN4542A Comparator Chassis Circuit Board Detail	2-SP5253351-3
-- QRN4542A Comparator Chassis Parts List	2PL-SP5253351
-- QCN1218A Comparator Chassis Rear View	9-SP5253351
-- QGN6422A Connector Panel Parts List	12PL-SP5253351

2. MODEL COMPLEMENT

The QCN1218A Chassis consists of the following items:

- QCN6127B Chassis
- QKN4024A Cable
- QGN6422A Connector Panel
- QRN4542A Interconnect Board

3. DESCRIPTION

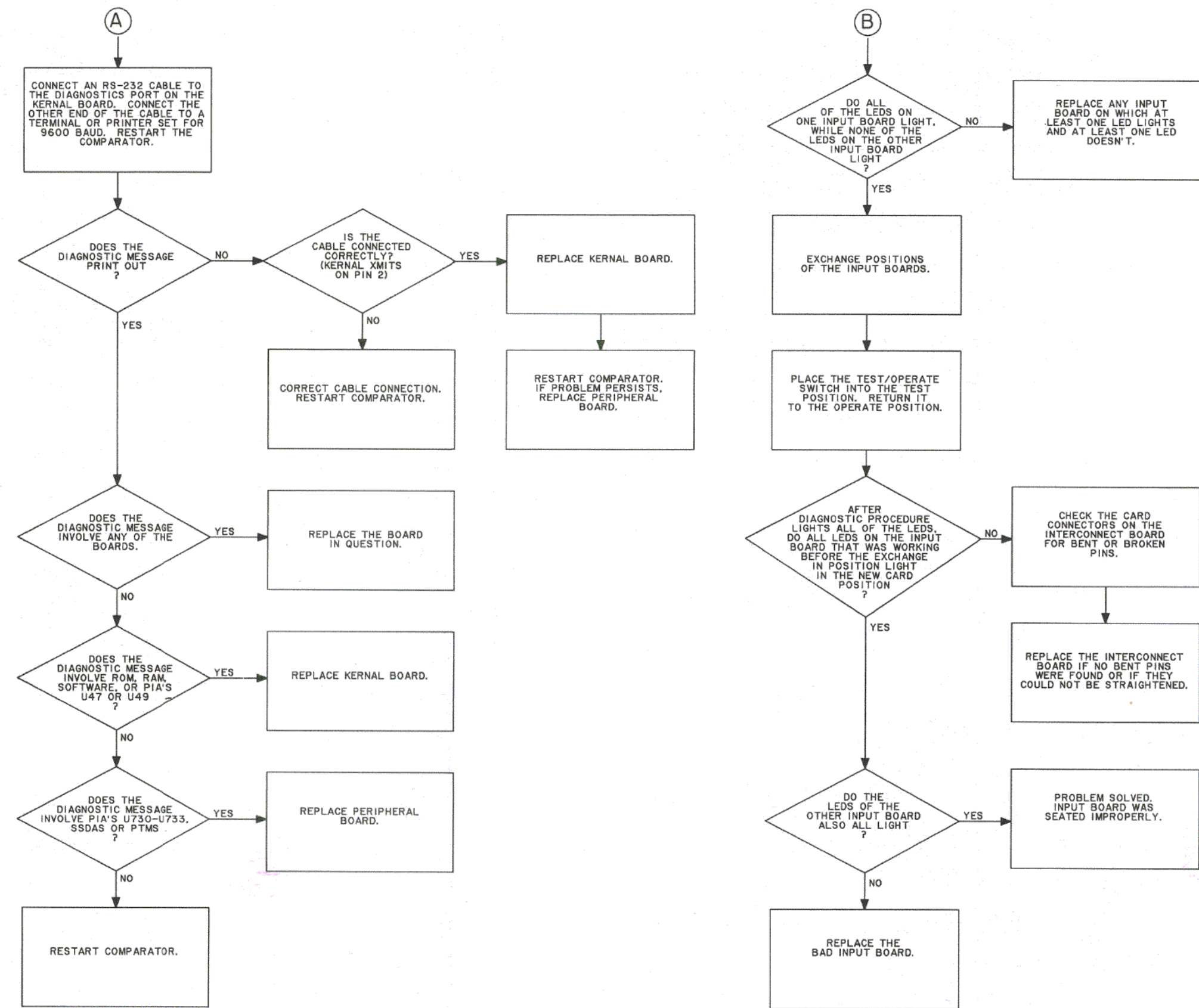
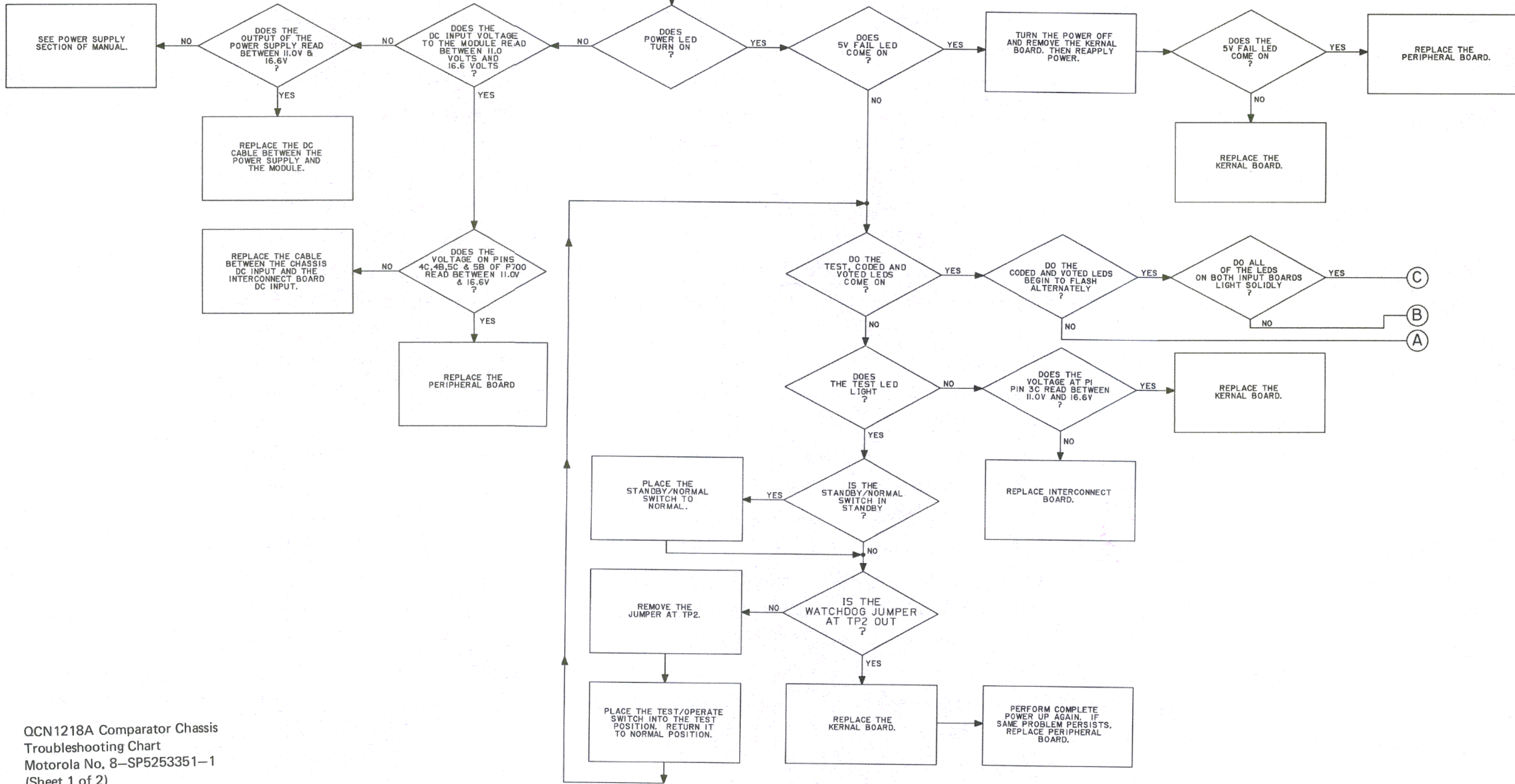
3.1 The QCN1218A Comparator Chassis contains the card cage and hardware that provides mounting facilities for the various circuit boards used in the comparator along with the QRN4542A Interconnect Board. The chassis also provides mounting facilities for the various input/output cable connectors.

3.2 The QKN4024A Cable provides dc input power to the interconnect board of the comparator as it interconnects between dc power supply input connector P800 and the QRN4542A Interconnect Board.

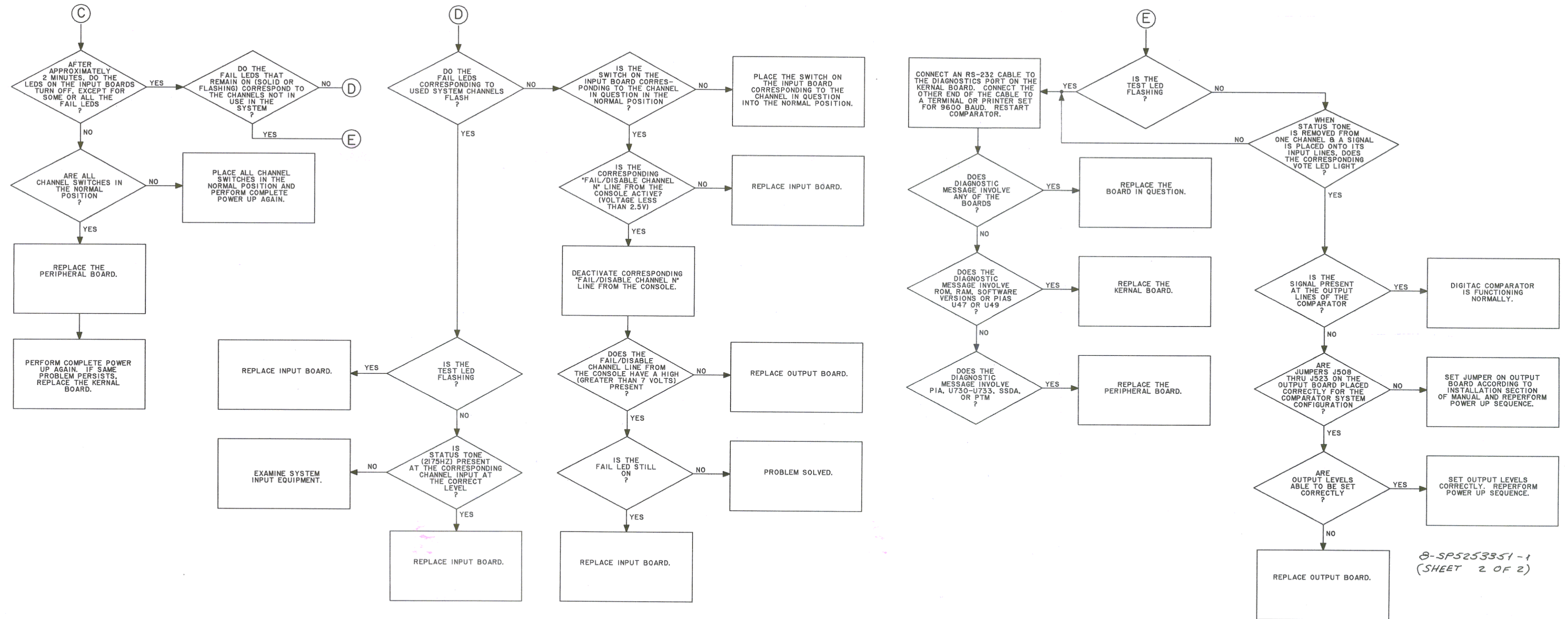
3.3 The QRN4542A Interconnect Board provides all the signal paths and dc power distribution required between the plug-in circuit boards and the input/output signal and power connectors mounted on the chassis.

4. MAINTENANCE

Maintenance of the QCN1218A Comparator Chassis consists of isolating a fault to a particular circuit board, power supply, or interconnect board and replacing the faulty component. Most of the fault isolation is performed by the power-up diagnostics which provides an indication of a faulty circuit board or channel. Attached troubleshooting chart 8-SP5253351 provides additional fault isolation procedures to identify faults to circuits not necessarily tested by the power-up diagnostics. Refer to the troubleshooting chart if replacing a board (as indicated by the power-up diagnostics), does not clear the problem.



8-SP5253351-1
(SHEET 1 OF 2)



8-SP5253351-1
(SHEET 2 OF 2)

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		<u>NON-REFERENCED ITEMS:</u>
	0383498N10	SCREW, tapping: M3.5 x 0.6 x 8; 28 used
	1506932M02	COMPARATOR, card cage
	2606933M01	SHIELD, static
	6406934M02	PANEL, blank

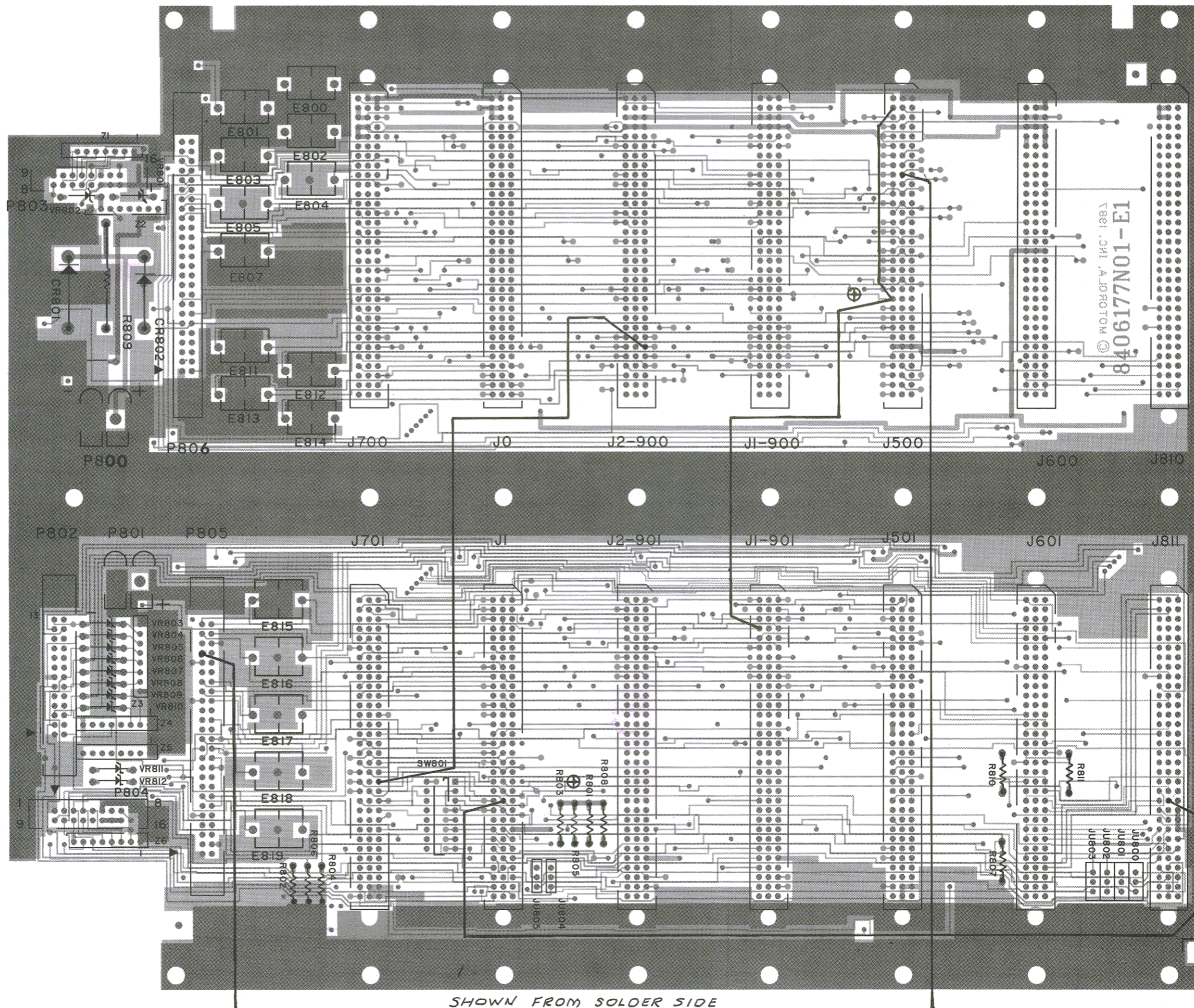
PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	1583183N05	<u>CONNECTOR</u> , plug: housing, 2-contact
	1583184N03	<u>CONNECTOR</u> , receptacle housing, 2-contact
	2983113N01	<u>MECHANICAL PARTS:</u> TERMINAL, insulator; red
	3983146N01	CONTACT, receptacle; 4 used
	4210217A02	STRAP, tie: .091 x 3.62"; 4 used

SOURCE/DESTINATION		SIGNAL	
EXPANSION BUS IN (P804)		108K CLK	
EXPANSION BUS OUT (P803)		13.8V	
CONSOLE RS232 (P802)		13.8V	
AUDIO CONNECTOR (P806)		13.8V	
CONTROL CONNECTOR (P805)		13.8V	
TX CONTROL BOARD 2 (J811)		13.8V	
TX CONTROL BOARD 1 (J810)		13.8V REG	
TX AUDIO BOARD 2 (J601)		ACTIVE CHNL 1	
TX AUDIO BOARD 1 (J600)		ACTIVE CHNL 2	
OUTPUT BOARD 2 (J501)		ACTIVE CHNL 3	
OUTPUT BOARD 1 (J500)		ACTIVE CHNL 4	
INPUT BOARD NO.2 J2-901 (CHANNELS 5-8)		ACTIVE CHNL 5	
INPUT BOARD NO.1 J1-901 (CHANNELS 5-8)		ACTIVE CHNL 6	
INPUT BOARD NO.2 J2-900 (CHANNELS 1-4)		ACTIVE CHNL 7	
INPUT BOARD NO.1 J1-900 (CHANNELS 1-4)		ACTIVE CHNL 8	
PERIPHERAL BOARD 2 (J701)		A/D CS 1	
PERIPHERAL BOARD 1 (J700)		A/D CS 2	
KERNAL BOARD 2 (J1)		A/D DI	
KERNAL BOARD 1 (J0)		A/D DI 1	
		A/D DI 2	
		A/D DO	
		A/D DO 1	
		A/D DO 2	
		A/D EOC	
		A/D SCLK	
		AGC CLK	
		AGC DATA	
		AGC ENBL 1	
		AGC ENBL 2	
		AGC ENBL 3	
		AGC ENBL 4	
		AGC ENBL 5	
		AGC ENBL 6	
		AGC ENBL 7	
		AGC ENBL 8	
		AUDIO CLK	
		AUDIO DATA	
		AUX OUT	
		AUDIO SOURCE CHNL 1	
		AUDIO SOURCE CHNL 2	
		AUDIO SOURCE CHNL 3	
		AUDIO SOURCE CHNL 4	
		AUDIO SOURCE CHNL 5	
		AUDIO SOURCE CHNL 6	
		AUDIO SOURCE CHNL 7	
		AUDIO SOURCE CHNL 8	
		BA1	
		BA2	
		BA3	
		BA6	
		BA7	
		BA8	
		BA1T SENSE	
		BA 1	
		BA 2	
		BA 3	
		BA 4	
		BA 5	
		BA 6	
		BA 7	
		BA 8	
		BD0	
		BD1	
		BD2	
		BD3	
		BD4	
		BD5	
		BD6	
		BD7	
		BD 0	
		BD 1	
		BD 2	
		BD 3	
		BD 4	
		BD 5	
		BD 6	
		BD 7	
		BE	
		BFIA	
		BRST	
		BRW	
		BSDA	
		CLEAR DISABLE	
		CLK IN +	
		CLK IN -	
		CLK OUT +	
		CLK OUT -	
		CNTL CLK 1	
		CNTL CLK 2	
		CODED DISABLE	
		CONSOLE AUDIO +	
		CONSOLE AUDIO -	
		CONSOLE AUDIO OUT	
		CONSOLE DISABLE	
		CONSOLE DSR	
		CONSOLE DTR	
		CONSOLE IN 1	
		CONSOLE IN 2	
		CONSOLE OUT 1	
		CONSOLE OUT 2	
		CONSOLE RX DATA	
		CONSOLE TEST IN	
		CONSOLE TONES +	
		CONSOLE TONES -	
		CONSOLE TX DATA	
		CON ACTIVE	
		CON ACT CODED	
		CON IN ACT	
		CON PRI	
		CS	
		DATA IN +	
		DATA IN -	
		DATA OUT +	
		DATA OUT -	
		DIGITAL GND	
		DIGITAL GND	
		DIGITAL GND	
		DIGITAL GND	
		DIGITAL GND	
		DRIVER CLK	
		DRIVER CLK	
		DVP SQ	
		DVP SQ 1	
		DVP SQ 2	
		DVP SQ 3	
		DVP SQ 4	
		DVP SQ 5	
		DVP SQ 6	
		DVP SQ 7	
		DVP SQ 8	
		E11	
		E12	
		E13	
		E14	
		E15	
		EOC 1	
		EOC 2	
		EXT LOOPBACK AUDIO	
		FAIL DISABLE 1	
		FAIL DISABLE 2	
		FAIL DISABLE 3	
		FAIL DISABLE 4	

QRN4542A Comparator Interconnect Board
Interconnect Charts and Circuit Board Detail
Motorola No. 2-SP5253351-2
(Sheet 2 of 3)
2/23/83

2-SP5253351-2
SHEET 2 OF 3



⊕ = FEEDTHROUGH
DRILLED OUT

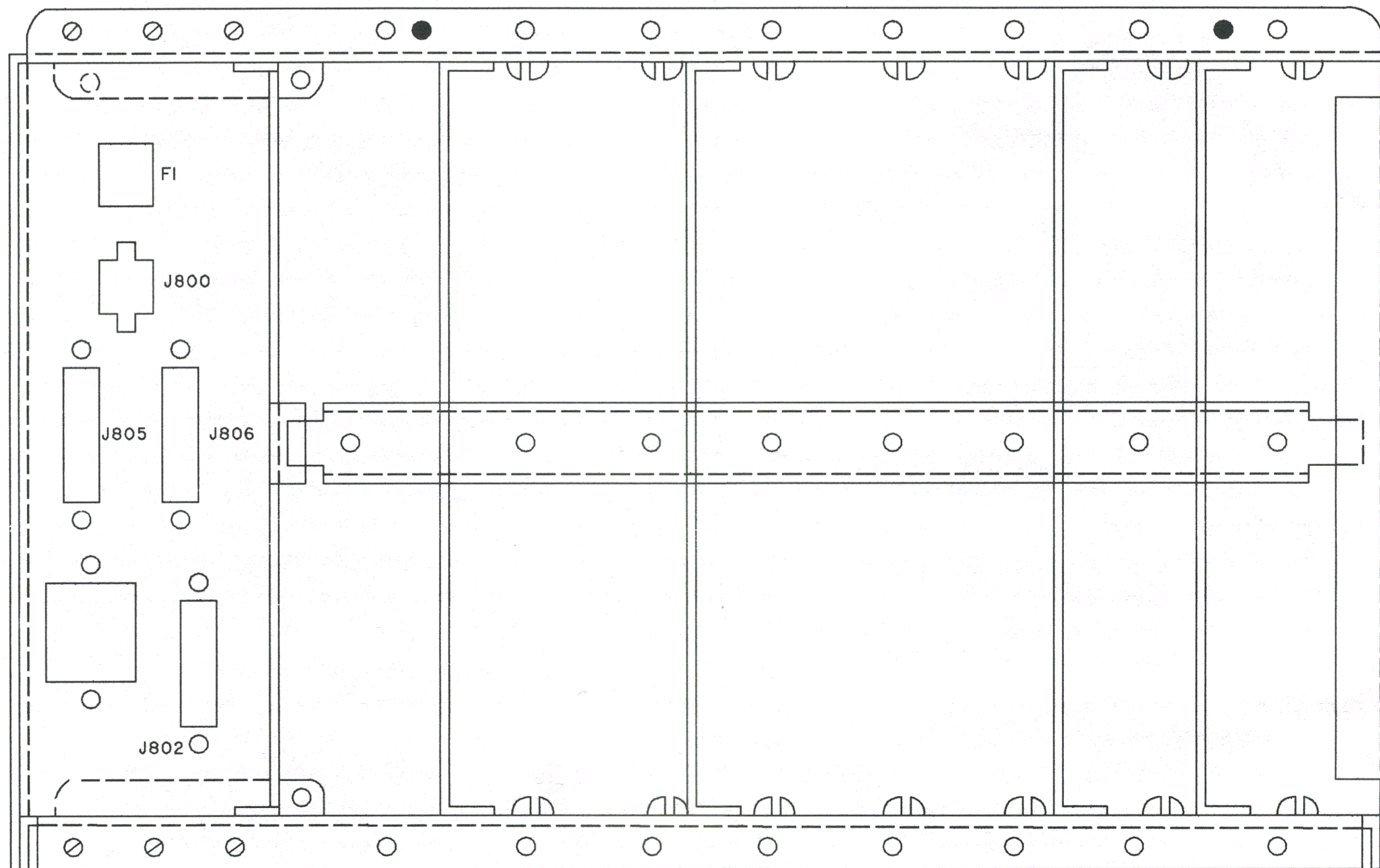
2-SP5253351-2
(SHEET 3 OF 3)

SHOWN FROM SOLDER SIDE

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
CR1, CR2	4882525G18	<u>DIODE:</u> (SEE NOTE) silicon, 50 V
E800 thru E805	8083545L08	<u>SPARK GAP:</u> 108 V
E807	8083545L08	108 V
E811 thru E819	8083545L08	108 V
J0, J1	2806344B08	<u>CONNECTOR:</u> 96 contact, male
J500, J501	2806344B08	96 contact, male
J600, J601	2806344B08	96 contact, male
J700, J701	2806344B08	96 contact, male
J810, J811	2806344B08	96 contact, male
J1-900	2806344B08	96 contact, male
J1-901	2806344B08	96 contact, male
J2-900	2806344B08	96 contact, male
J2-901	2806344B08	96 contact, male
P800, P801	2883636P14	<u>PLUG:</u> board mounting, 2 contact
P802	2806465L05	header, 26 pin
P803, P804	2806140C17	connector, right angle; 16 pin
P805, P806	2883136N04	header, 50 pin
R1 thru R6	0611009A49	<u>RESISTOR:</u> all FCF: $\pm 5\%$; 1/4 W unless specified otherwise 1k
R7, R8	0611009A65	4.7k
R9	1782177B07	20 ohms, FWW: 5 W
R10, R11	0611009A45	680 ohms
Ju800 thru Ju805	0611009F23	res. jumper; 0 ohms
SW801	4083849F02	<u>SWITCH:</u> DIP, rocker; 8 position
VR7 thru VR18	4883461E02	<u>ZENER DIODE:</u> (SEE NOTE) 13 V

NOTE: For optimum performance, diodes, transistors, and integrated circuits must be ordered by Motorola part numbers.



COMPARATOR CHASSIS, REAR VIEW

9-SP5253351-1

○ HOLES FOR STRAIN RELIEF CLIPS FOR CABLES FROM J805, J806.

QCN1218A Comparator Chassis
Rear View
Motorola No. 9-SP5253351-1
1/5/88

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	0384398N10	SCREW, tapping: M3.5 x 0.6 x 8; 7 used
	0383498N12	SCREW, tapping: M3 x 0.5 x 12
	0706106N01	CONNECTOR MOUNTING BRACKET
	0706107N01	FILTER RETAINER BRACKET
	0706107N02	FILTER RETAINER BRACKET, 2 used
	0983756R01	SNAP IN FUSE HOLDER
	3006948M05	FLAT CABLE WITH CONNECTORS
	3006948M06	FLAT CABLE WITH CONNECTORS, 2 used
	4206109N01	FERRITE CLIP, 6 used
	4310646A09	STANDOFF, 4-40 x 0.188; 2 used
	6500052293	FUSE, 5 amp @ 250 V
	7506108N01	FOAM PAD; 2 used
	7506108N02	FOAM PAD; 4 used
	7606110N01	FERRITE FILTER; 2 used
	7606110N02	FERRITE FILTER; 4 used



DIGITAC™ COMPARATOR

KERNEL BOARD

MODEL QRN4304B

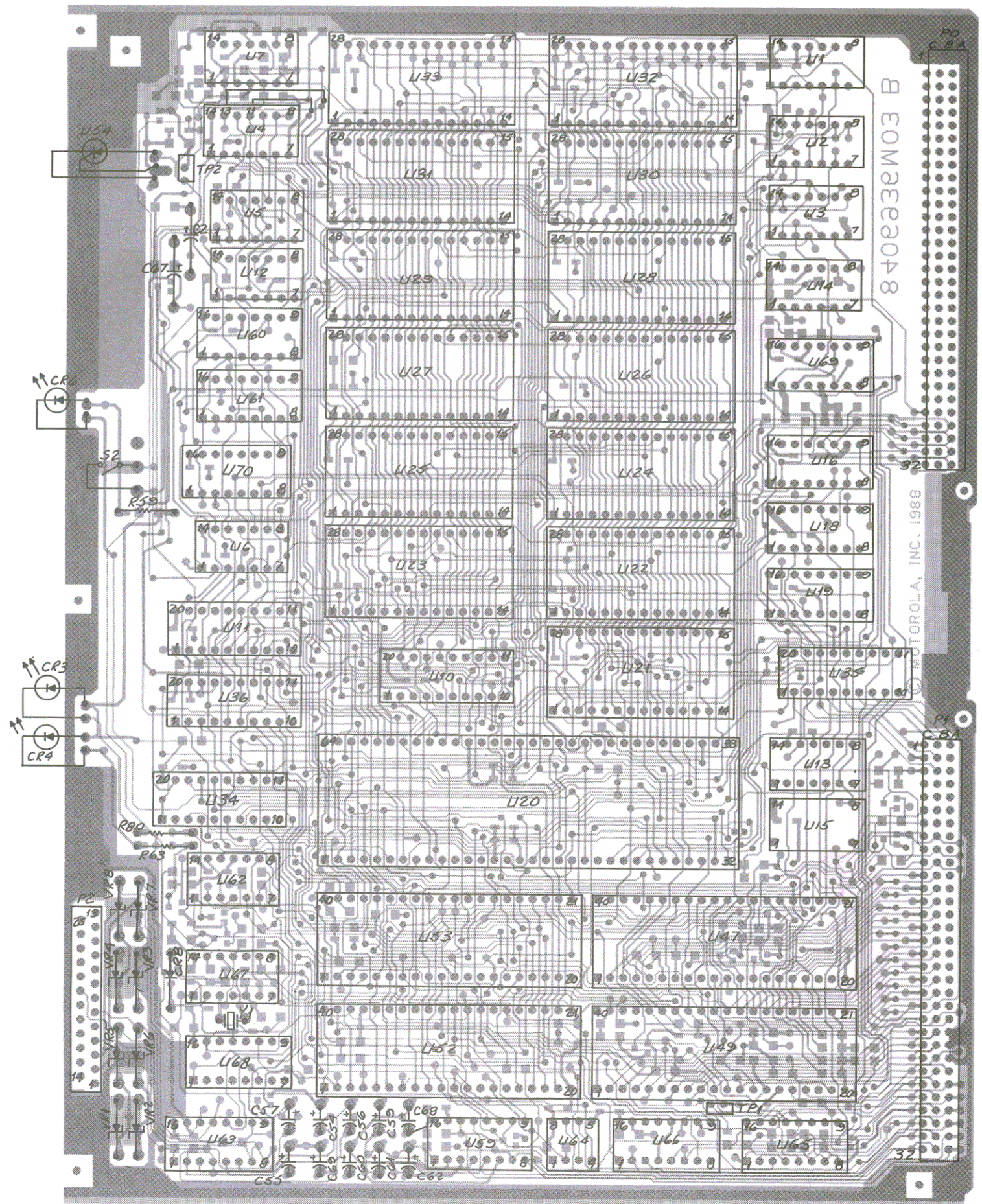
1. ATTACHMENTS

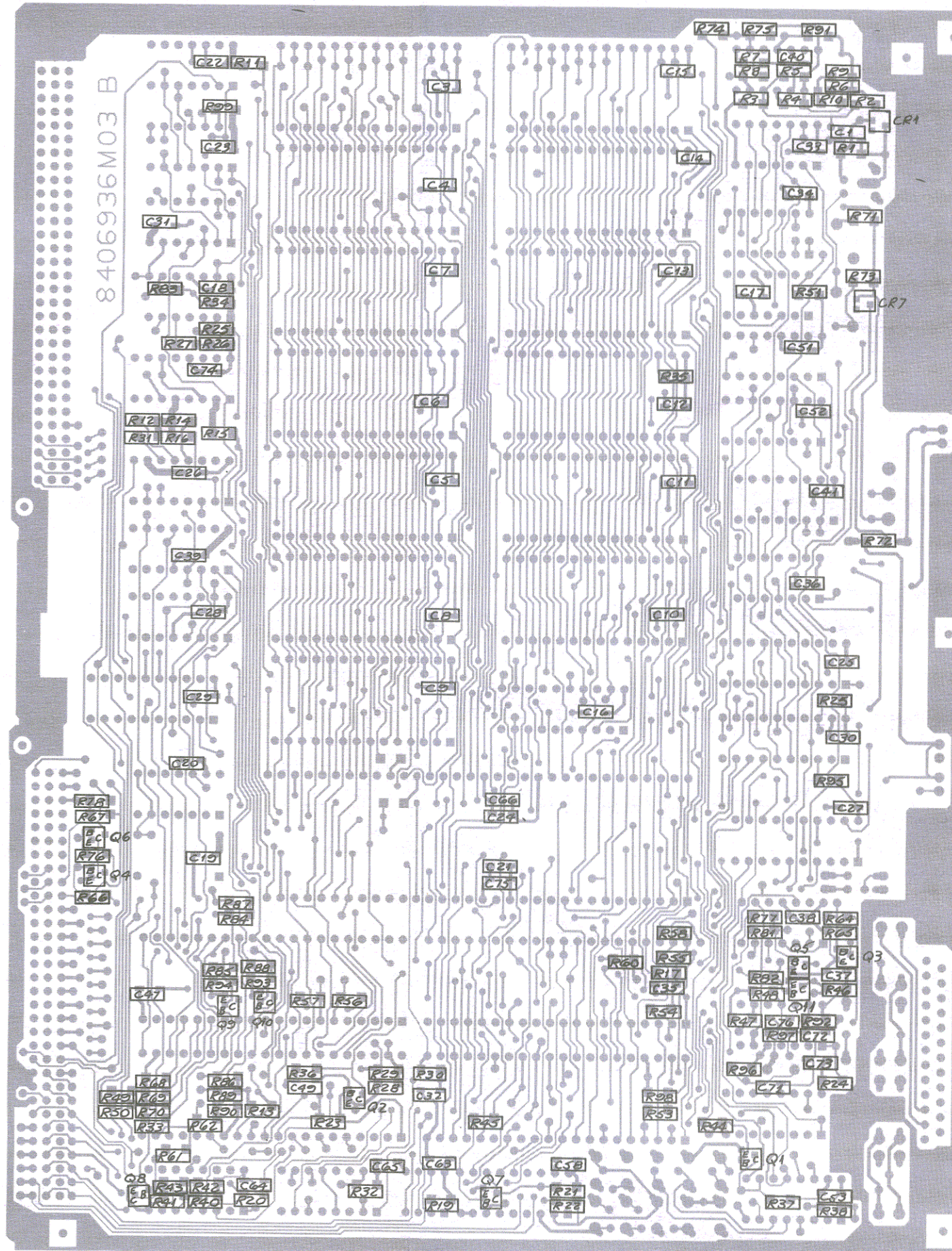
-- QRN4304B Kernel Board Circuit Board Detail (component side)	21-SP5252359-1
-- QRN4304B Kernel Board Circuit Board Detail (solder side)	21-SP5252359-2
-- QRN4304B Kernel Board Schematic Diagram (sheet 1)	22-SP5252359-1
-- QRN4304B Kernel Board Schematic Diagram (sheet 2)	22-SP5252359-2
-- QRN4304B Kernel Board Parts List	23PL-SP5252359

2. DESCRIPTION

2.1 The QRN4304B Kernel board is a plug-in circuit board that contains a microprocessor and its supporting circuitry. This includes Read Only Memory (ROM), Random Access Memory (RAM), and control circuitry. The control circuitry includes address/data decoding circuitry and input/output circuitry such as external communications circuitry for the expansion bus. The board also contains a watchdog circuit used to monitor the performance of the microprocessor. Should the processor become 'lost' during code execution, the watchdog timer resets it to a power-up condition. The Kernel board also contains address, control, and data line buffering for communication with the peripheral board.

2.2 Controls on this board include the **Test/Operate** switch and the red **Test** LED as the associated indicator. The **Coded** (green) LED and the **Voted** (yellow) LED serve as an indication of the coded or clear modes of operation. All controls are mounted on the front panel/pull handle of the board.

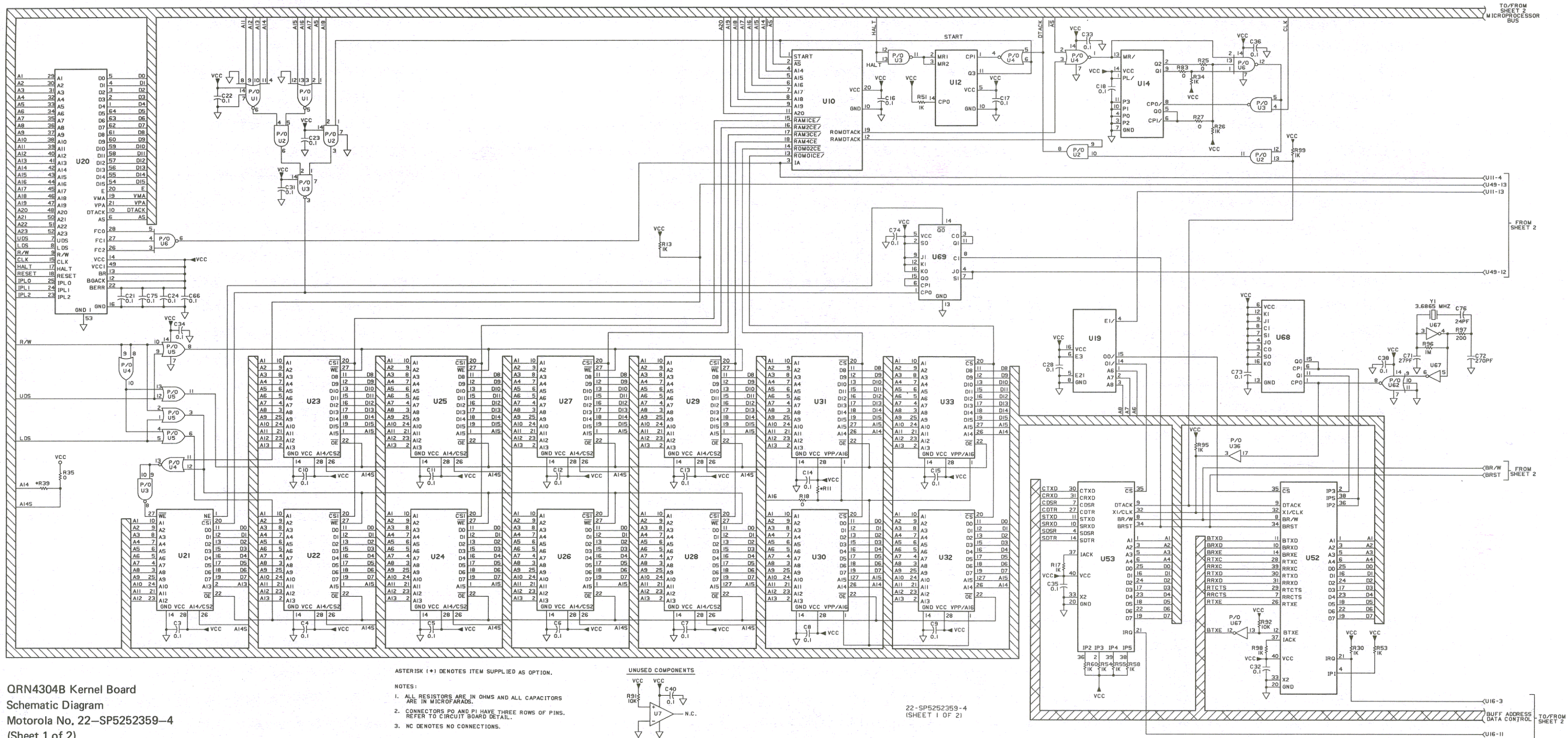


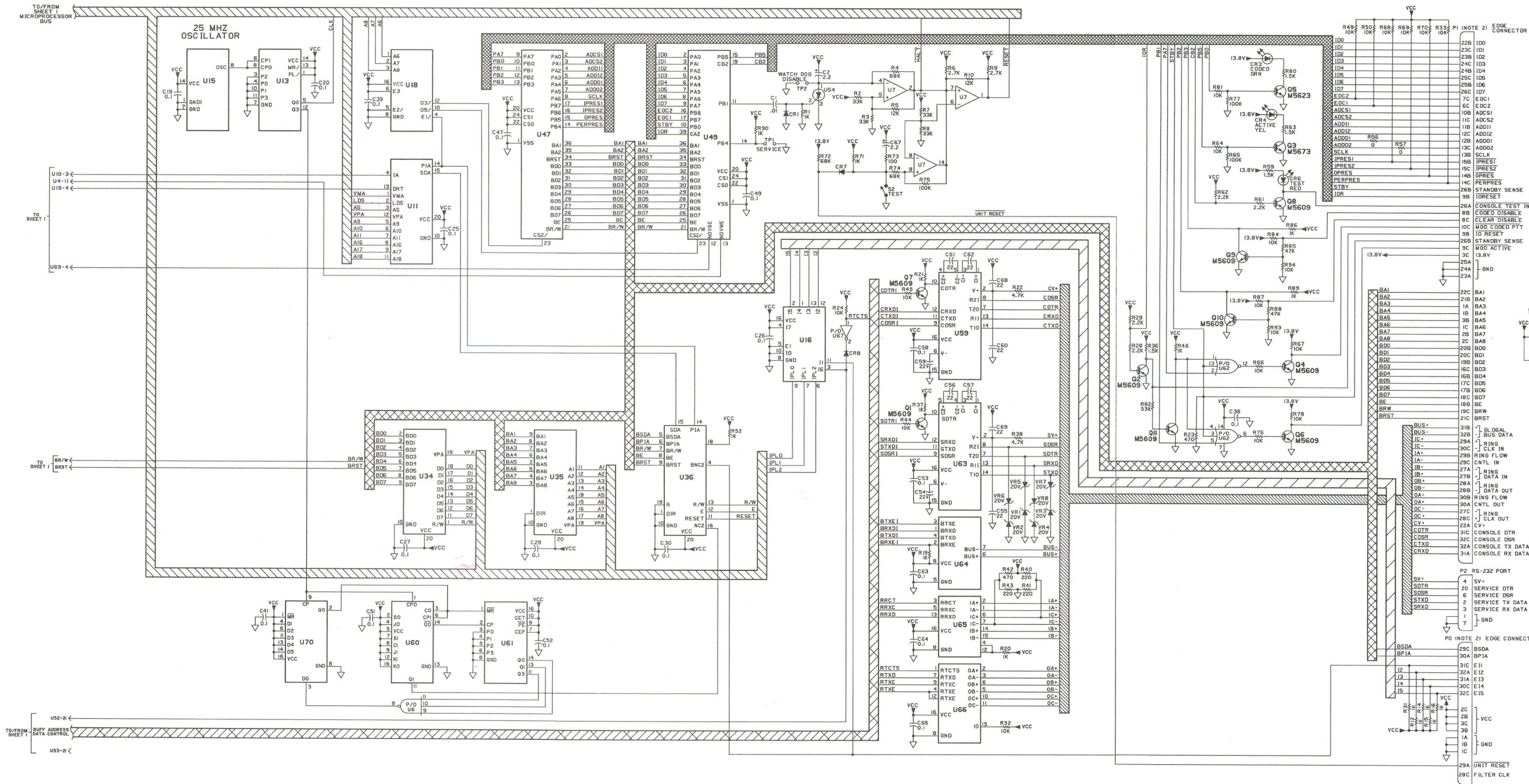


SHOWN FROM SOLDER SIDE

21-SP5252359-3
(SHEET 2 OF 2)

QRN4304B Kernel Board
Circuit Board Details, Solder Side Components
Motorola No. 21-SP5252359- 3
(Sheet 2 of 2)
7/5/88





QRN4304B Kernel Board
Schematic Diagram
Motorola No. 22-SP5252359-4
(Sheet 2 of 2)
7/29/88

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		<u>CAPACITOR, fixed:</u> chip, uF $\pm 5\%$; 50 V
C1	2111032A21	0.01 $\pm 10\%$
C2	2384762H04	2.2 $\pm 20\%$ 25 V
C3 thru C41	2111032A33	0.10 $\pm 10\%$
C47	2111032A33	0.10 $\pm 10\%$
C49	2111032A33	0.10 $\pm 10\%$
C51 thru C53	2111032A33	0.10 $\pm 10\%$
C54 thru C57	2311019A27	22 $\pm 20\%$ 25 V
C58	2111032A33	0.10 $\pm 10\%$
C59 thru C62	2311019A27	22 $\pm 20\%$ 25 V
C63 thru C66	2111032A33	0.10 $\pm 10\%$
C67	2384762H04	2.2 $\pm 20\%$ 25 V
C68, C69	2311019A27	22 $\pm 20\%$ 25 V
C71	2111031A25	27 pF $\pm 5\%$
C72	2111031A49	270 pF $\pm 5\%$
C73 thru C75	2111032A33	0.10 $\pm 10\%$
C76	2111031A24	24 pF $\pm 5\%$ 50 V
		<u>DIODE:</u> (SEE NOTE)
CR1, CR7	4811058C11	silicon
CR8	4884616A01	hot carrier
		<u>LIGHT EMITTING DIODE:</u> (see note)
CR3	4888245C22	grn
CR4	4888245C23	yel
CR6	4888245C24	red
		<u>CONNECTOR,</u> receptacle:
P0, P1	0982236R01	receptacle 3 x 32 contact 90 deg
P2	0906320B35	receptacle 25 contact
		<u>TRANSISTOR:</u>
Q1, Q2	4811056C09	NPN type M5609
Q3 thru Q6	4811056C23	NPN type M5623
Q7 thru Q11	4811056C09	NPN type M5609
		<u>RESISTOR,</u> fixed: chip, $\pm 5\%$; 1/8 W (unless otherwise stated)
R1	0611077A74	1000
R2, R3	0611077B11	33k
R4	0611077B19	68k
R5	0611077B01	12k
R6	0611077A84	2700
R7, R8	0611077B11	33k
R9	0611077A84	2700
R10	0611077B01	12k
R11	-----	optional

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R12 thru R17	0611077A74	1000
R18	0611077A01	jumper, 0 ohms
R19, R20, R21	0611077A74	1000
R22	0611077a90	4.7K
R23	0611077A66	470
R24	0611077A98	10k
R25	0611077A01	jumper, 0 ohms
R26	0611077A74	1000
R27	0611077A01	jumper, 0 ohms
R28, R29	0611077A82	2200
R30, R31	0611077A74	1000
R32	0611077A98	10k
R33, R34	0611077A74	1000
R35	0611077A01	jumper, 0 ohms
R36	0611077A78	1500
R37	0611077A74	1000
R38	0611077a90	4.7K
R39	-----	optional
R40, R41, R43	0611077A58	220
R42	0611077A66	470
R44, R45	0611077A98	10k
R46	0611077A74	1000
R47, R48	0611077A98	10k
R49 thru R55	0611077A74	1000
R56, R57	0611077A01	jumper, 0 ohms
R58	0611077A74	1000
R59	0611077A53	1500, 1/4 W
R60	0611077A74	1000
R61, R62	0611077A82	2200
R63	0611077A53	1500, 1/4 W
R64	0611077A98	10k
R65	0611077B23	100k
R66, R67	0611077A98	10k
R68 thru R71	0611077A74	1000
R72	0611077B19	68k
R73	0611077A50	100
R74	0611077B19	68k
R75	0611077B23	100k
R76	0611077A98	10k
R77	0611077B23	100k
R78	0611077A98	10k
R80	0611077A53	1500, 1/4 W
R81	0611077A98	10k
R82	0611077B11	33k
R83	0611077A01	jumper, 0 ohms
R84	0611077A98	10k
R85	0611077B15	47k
R86	0611077A74	1000

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R87	0611077A98	10k
R88	0611077B15	47k
R89, R90	0611077A74	1000
R91 thru R94	0611077A98	10k
R95	0611077A74	1000
R96	0611077B47	1 meg
R97	0611077A57	200
R98, R99	0611077A74	1000
<u>SWITCH:</u>		
S2	4083249K13	SPST
<u>TEST POINT:</u>		
TP1, 2	2884318M06	plug, 2 pin
<u>INTEGRATED CIRCUIT:</u> (SEE NOTE)		
U1	5184118K84	dual 5-input NOR gate
U2	5183548N02	gates pos w/totem pole output
U3	5184118K06	quad NAND gate 2 input
U4	5184118K13	quad NOR gate 2 input
U5	5183627M31	gates pos or w/totem pole output
U6	5184118K29	NAND gate triple 3 input
U7	5184320A51	quad comparator
U10	5106370M46	programmable array logic
U11	5106370M37	programmable array logic
U12	5184118K04	counter binary 4 bit
U13	5184810F32	counter decade presettable
U14	5184118K52	counter programmable 4 bit binary
U15	4806413K03	crystal clock oscillator
U16	5184118K58	priority encoder 8 to 3 line
U18, U19	5184118K34	decoder 3-lin3 to 8-line
U20	5106472A92	microprocessor
U21	5106954M01	static RAM
U22 thru U29	5106332M03	static RAM
U30	5106370M79	64k x 8 EPROM
U31	5106370M80	64k x 8 EPROM
U32	5106370M81	64k x 8 EPROM
U33	5106370M82	64k x 8 EPROM
U34, U35, U36	5184118K80	octal trancivers bus
U47, U49	5184944N46	PIA
U52, U53	5106471A44	DUART
U54	4800869577	transisitor type M9577
U59	5106953M01	transmitter/receiver RS-232
U60	5184118K59	dual j-k flip-flop w/preset and clear
U61	5184118K44	4 bit binary sync counter
U62	5184118K18	NOR gate triple 3-input
U63	5106953M01	transmitter/receiver RS-232

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
U64	5106490A20	driver
U65	5184621K45	quad RS-422/423 line receiver
U66	5182848M52	quad line driver
U67	5183810P38	inverter
U68, U69	5184118K59	flip-flop dual j-k w/preset and clear
U70	5184118K46	flip-flop hex D type
VR1 thru VR8	4882256C39	<u>VOLTAGE REGULATOR:</u> (see note) Zener, 20 V
Y1	4882611M20	<u>CRYSTAL:</u> oscillator
		<u>NON-REFERENCE PARTS:</u>
	0982808R06	SOCKET, 20-contact; 2 used
	0982808R10	SOCKET, 28-contact; 13 used
	0982808R11	SOCKET, 40-contact; 2 used
	0982808R13	SOCKET, 64-contact; 1 used
	0984728L01	SOCKET, connector; 2 used
	4305885J03	INSERT THD METRIC; 4 used
	0200120945	NUT, 4-40 x 3/16 x 1/16"; 2 used
	0382009T01	SCREW, metric machine, 2.5 x 12"; 4 used
	0300400100	SCREW, machine 4-40 x 3/8"; 2 used
	0310943J14	SCREW, tapping TT3.5 x 0.6 x 6mm; 3 used
	0400009777	WASHER, lock #4 split; 6 used
	64-6935M08	PANEL, front kernel; 1 used
	7505295B01	PAD, crystal base
		NOTE: For optimum performance, diodes, transistors, and integrated circuits must be ordered by Motorola part numbers.



PERIPHERAL BOARD

INSTRUCTION SECTION

MODEL QRN4305B

1. ATTACHMENTS

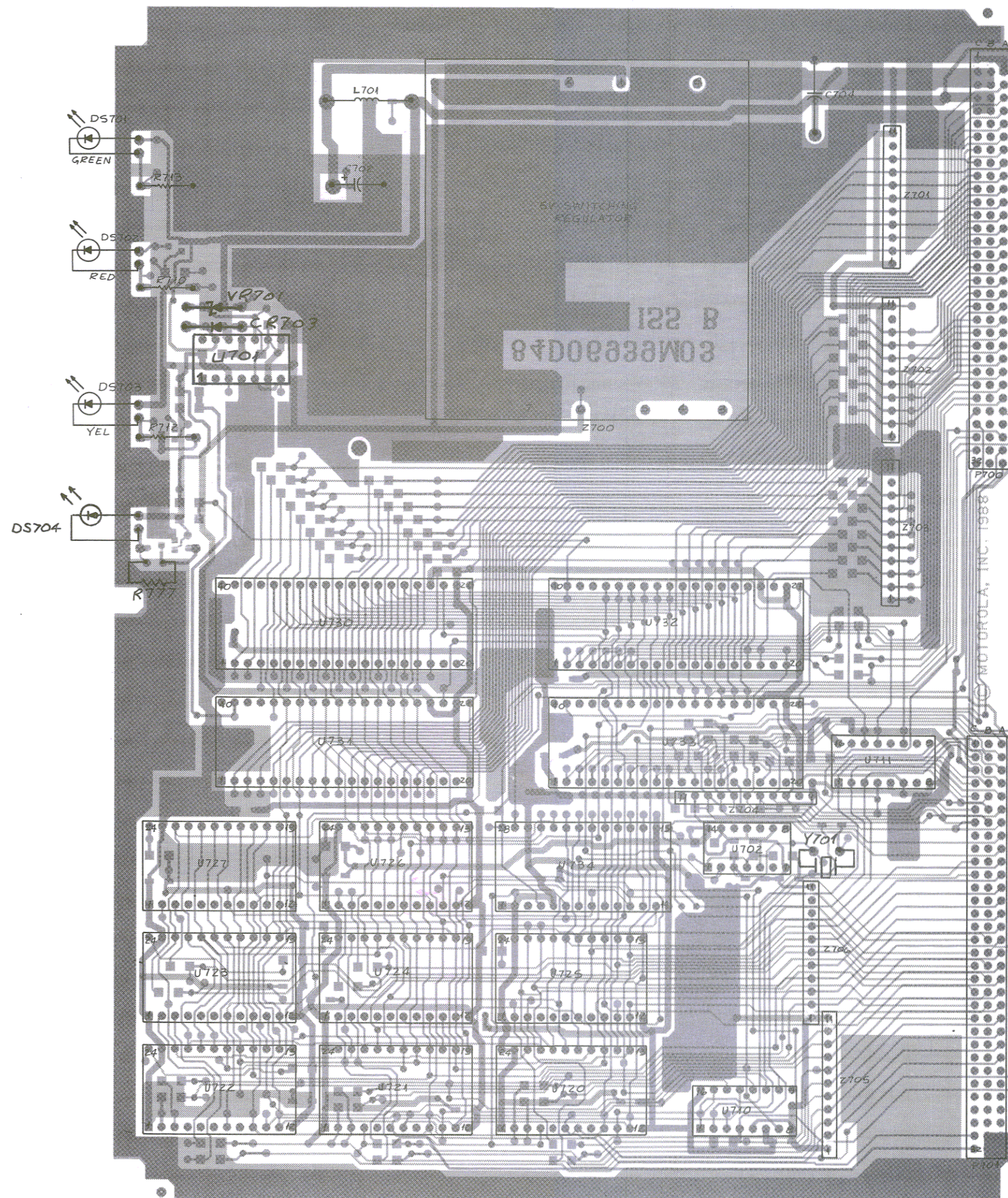
-- QRN4305B Peripheral Board Circuit Board Detail (component side)	26-SP5252359-1
-- QRN4305B Peripheral Board Circuit Board Detail (solder side)	26-SP5252359-2
-- QRN4305B Peripheral Board Schematic Diagram (sheet 1)	27-SP5252359-1
-- QRN4305B Peripheral Board Schematic Diagram (sheet 2)	27-SP5252359-2
-- QRN4305B Peripheral Board Parts List	28PL-SP5252359

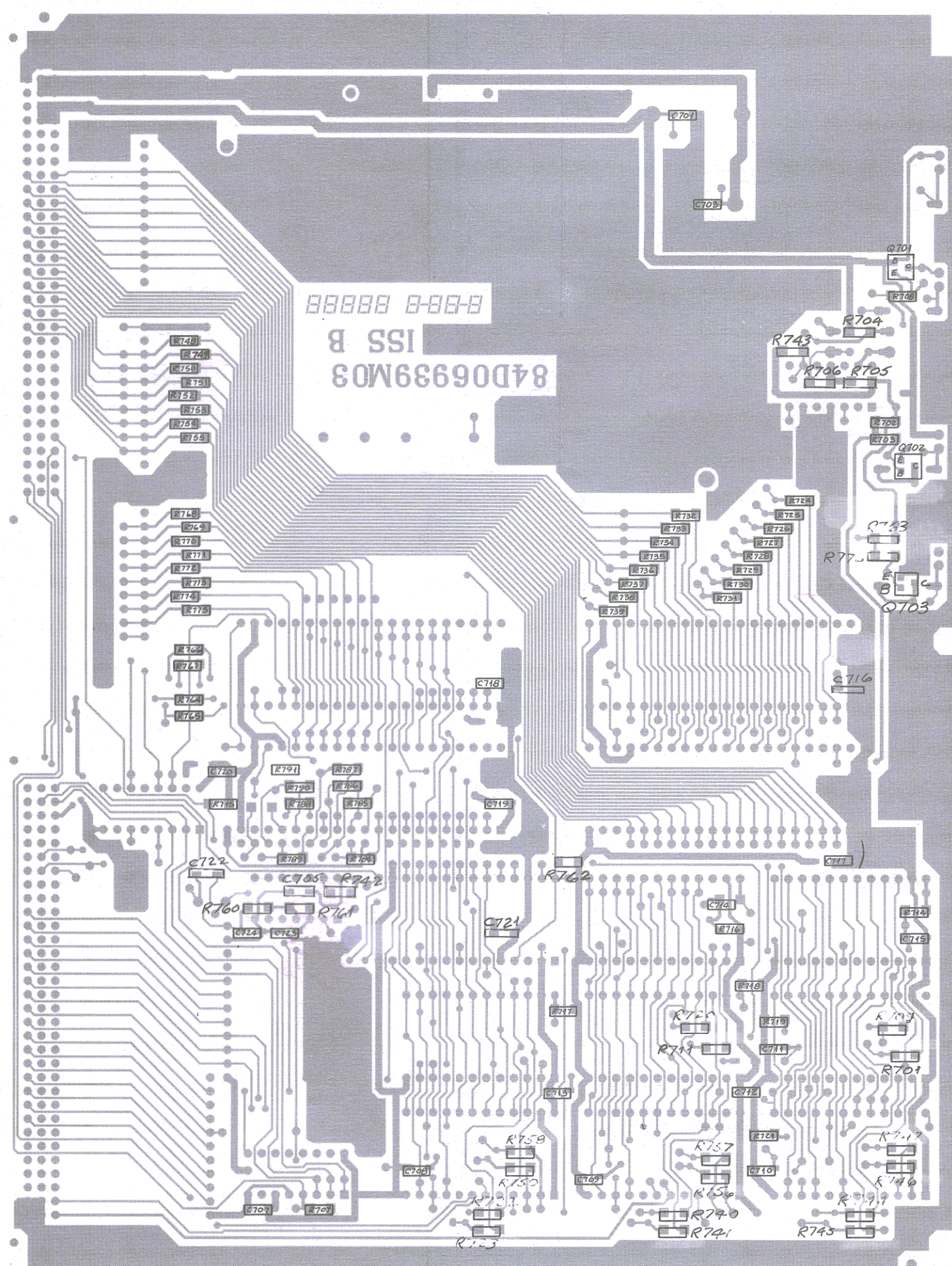
2. DESCRIPTION

2.1 The QRN4305B Peripheral Board is a plug-in circuit board that contains the majority of the I/O circuitry for the microprocessor. Specifically, the major circuit blocks are the PIAs and SSDAs which condition and interface all the inputs to the microprocessor on the Kernel board.

2.2 These devices read the incoming switch, control line, and signal status data from the other boards and convert this into a form which is convenient for the microprocessor to read. It also translates data from the microprocessor into commands and status updates for the audio circuitry and indicators. The Peripheral board also contains a 13.8V to 5V DC-to-DC converter to supply power to the Kernel and Peripheral boards.

2.3 Controls on this board include the green Power LED, the red 5V Fail LED, and the yellow Battery LED. All controls are mounted on the front panel/pull handle of the board.

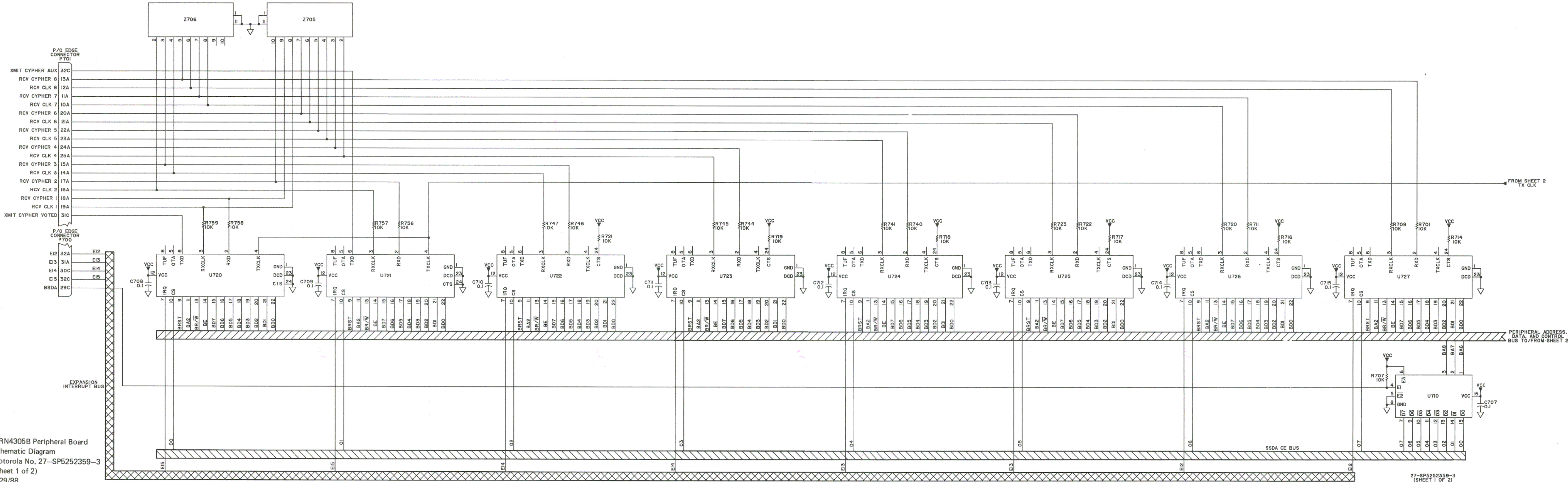


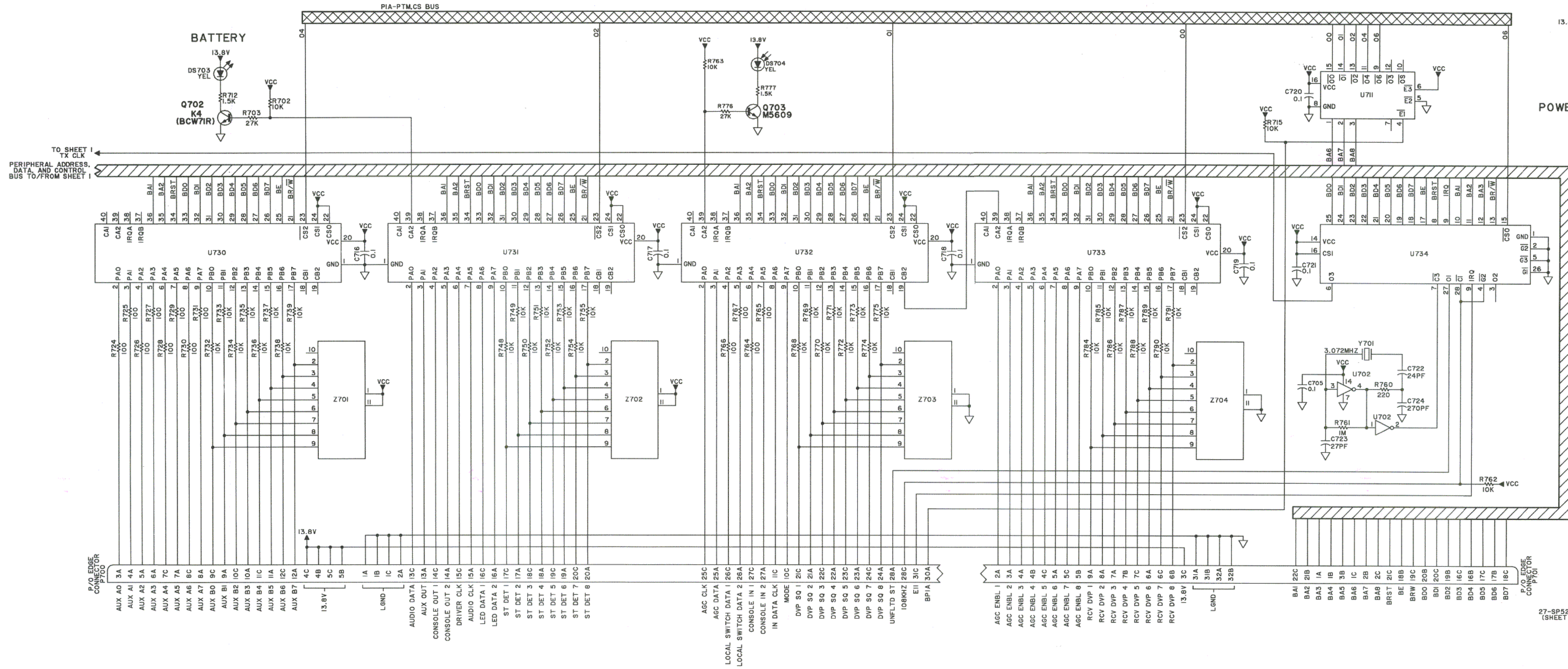


SHOWN FROM SOLDER SIDE

26-SP5252359-3
(SHEET 2 OF 2)

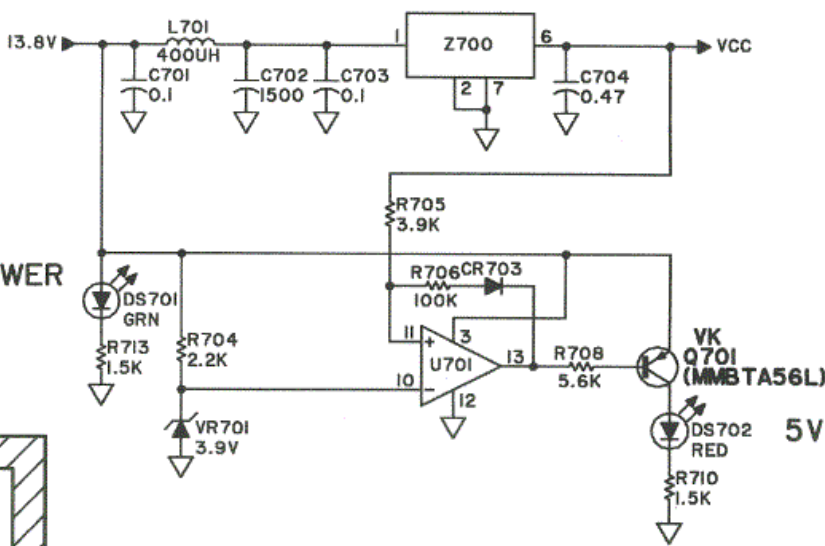
QRN4305B Peripheral Board
Circuit Board Details
Motorola No. 26-SP5252359-3
(Sheet 2 of 2)
7/5/88





27-SP5252359-3
(SHEET 2 OF 2)

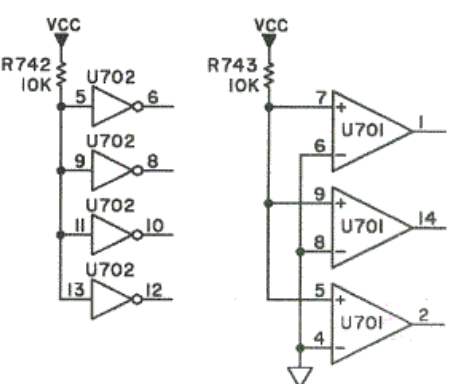
POWER



NOTES:

1. ALL RESISTORS ARE IN OHMS, CAPACITORS IN MICROFARADS, AND INDUCTORS IN MICROHENRYS.
2. BOTH CONNECTORS HAVE THREE ROWS OF PINS, REFER TO CIRCUIT BOARD DETAIL.

UNUSED COMPONENTS



PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		<u>CAPACITOR, fixed:</u> chip, uF +80-20%; 50 V unless otherwise stated
C701	2111032A33	0.1 ±10%
C702	2382747L29	alu 1500 -10+10%; 40 V
C703	2111032A33	0.1 ±10%
C704	0884637L42	mtlz polyest 0.47 ±10%; 100 V
C705	2111032A33	0.1 ±10%
C707 thru C721	2111032A33	0.1 ±10%
C722	2111031A24	24 pF ±5%; 50 V
C723	2111031A25	27 pF ±5%; 50 V
C724	2111031A49	270 pF ±5%; 50 V
		<u>DIODE:</u> (see note) silicon
CR703	4883654H01	
		<u>LIGHT EMITTING DIODE:</u> (see note)
DS701	4888245C22	grn
DS702	4888245C24	red
DS703	4888245C23	yel
DS704	4888245C23	yel
		<u>COIL,</u> rf: toroid
L701	2482380N01	
		<u>CONNECTOR, plug:</u> receptacle 3 x 32 contact 90 deg
P700, P701	0982236R01	
		<u>TRANSISTOR:</u> (SEE NOTE)
Q701	4811056C08	PNP type M5608
Q702	4811056C09	NPN type M5609
Q703	4811056C09	NPN type M5609
		<u>RESISTOR, fixed:</u> chip, ±5%; 1/8 W (unless otherwise stated)
R701, R702	0611077A98	10k
R703	0611077B09	27k
R704	0611077A82	2200
R705	0611077B23	3.9k
R706	0611077A92	100K
R707, R709, R711	0611077A98	10k
R708	0611077A92	5600
R710	0611009A53	FCF 1500 1/4 W
R712, R713	0611009A53	FCF 1500 1/4 W
R714 thru R721	0611077A98	10k
R724 thru R731	0611077A50	100

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R732 thru R755	0611077A98	10k
R763	0611077A98	10k
R764 thru R767	0611077A50	100
R768 thru R775	0611077A98	10k
R776	0611077B09	27k
R777	0611009A53	1.5k
R784 thru R791	0611077A98	10k
R720, R722, R723	0611077A98	10k
R740 thru R747	0611077A98	10k
R756 thru R759	0611077A98	10k
R760	0611077A58	20
R761	0611077B47	1 meg
R762	0611077A98	10k
<u>INTEGRATED CIRCUIT:</u> (SEE NOTE)		
U701	5184320A51	quad comparator
U702	5183810B38	Inverter
U710, U711	5184118K34	decoder 3-line to 8-line
U720 thru U727	5184944N48	synchronous serial data adapter
U730 thru U733	5184944N46	PIA
U734	5184944N47	programmable timer module
<u>VOLTAGE REGULATOR:</u> (SEE NOTE)		
VR701	4882256C46	Zener, 3.9 V
<u>CRYSTAL:</u>		
Y701	4882611M12	oscillator, 3.072 MHz
<u>HYBRID:</u>		
Z700	0611009A53	dc/dc converter
Z701 thru Z706	5182142K02	resistor network
non-referenced items		
	0310943J14	screw, tapping: TT3.5 x 0.6 x 6mm; 3 used
	0382009T01	screw, machine: 2-56 x 1/2"; 4 used
	0400009777	washer, lock: #2 split; 4 used
	6406935M07	panel, front peripheral
	7505295B01	pad, crystal base
	4305885J03	insert thrd. metric; 4 used

NOTE: For optimum performance, diodes, transistors, crystals, and integrated circuits must be ordered by Motorola part numbers.



INPUT BOARD

INSTRUCTION SECTION

MODEL QRN4306B

1. ATTACHMENTS

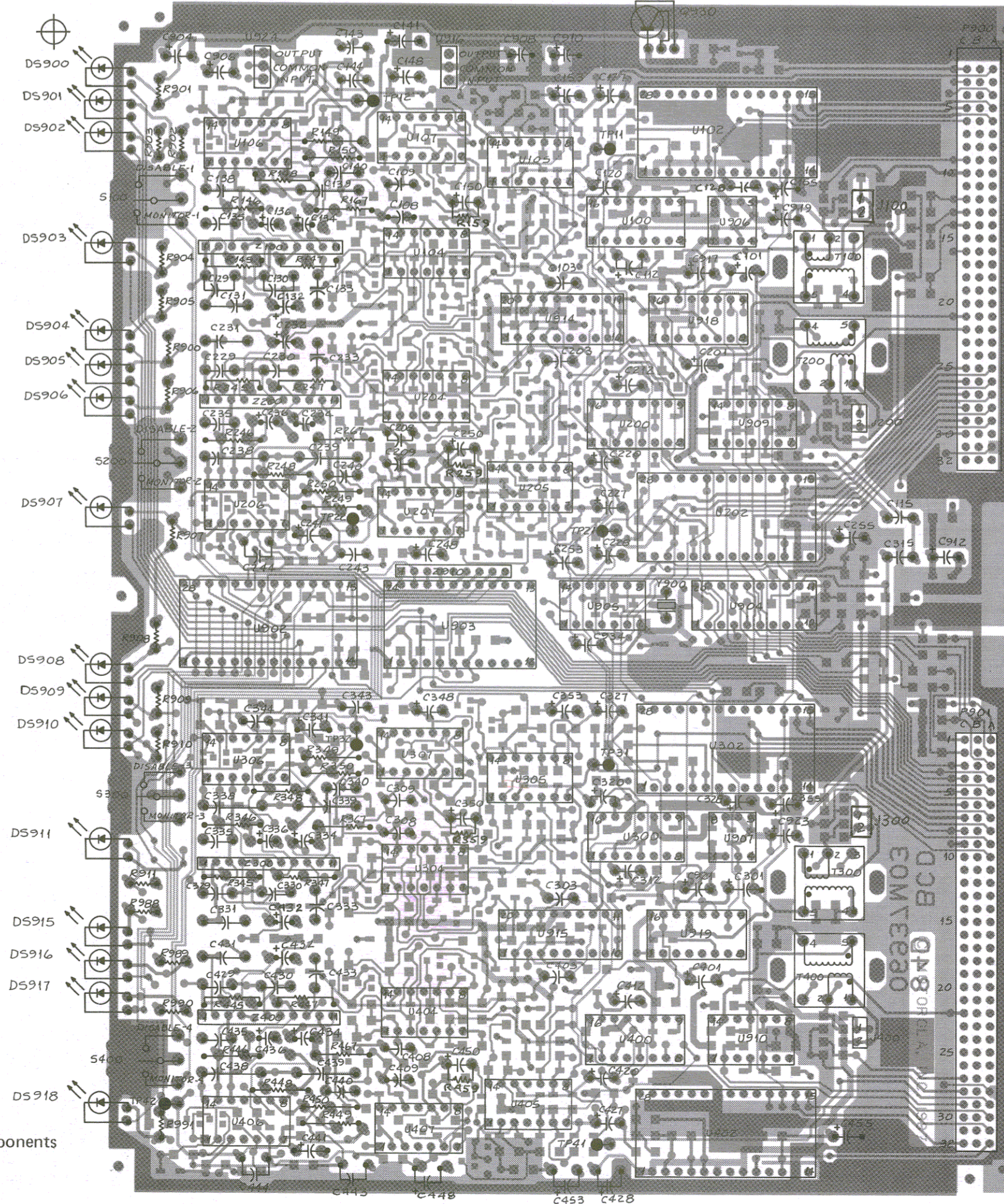
-- QRN4306B Input Board Circuit Board Detail (component side)	31-SP5252359-1
-- QRN4306B Input Board Circuit Board Detail (solder side)	31-SP5252359-2
-- QRN4306B Input Board Schematic Diagram (sheet 1)	32-SP5252359-1
-- QRN4306B Input Board Schematic Diagram (sheet 2)	32-SP5252359-2
-- QRN4306B Input Board Parts List	33PL-SP5252359

2. DESCRIPTION

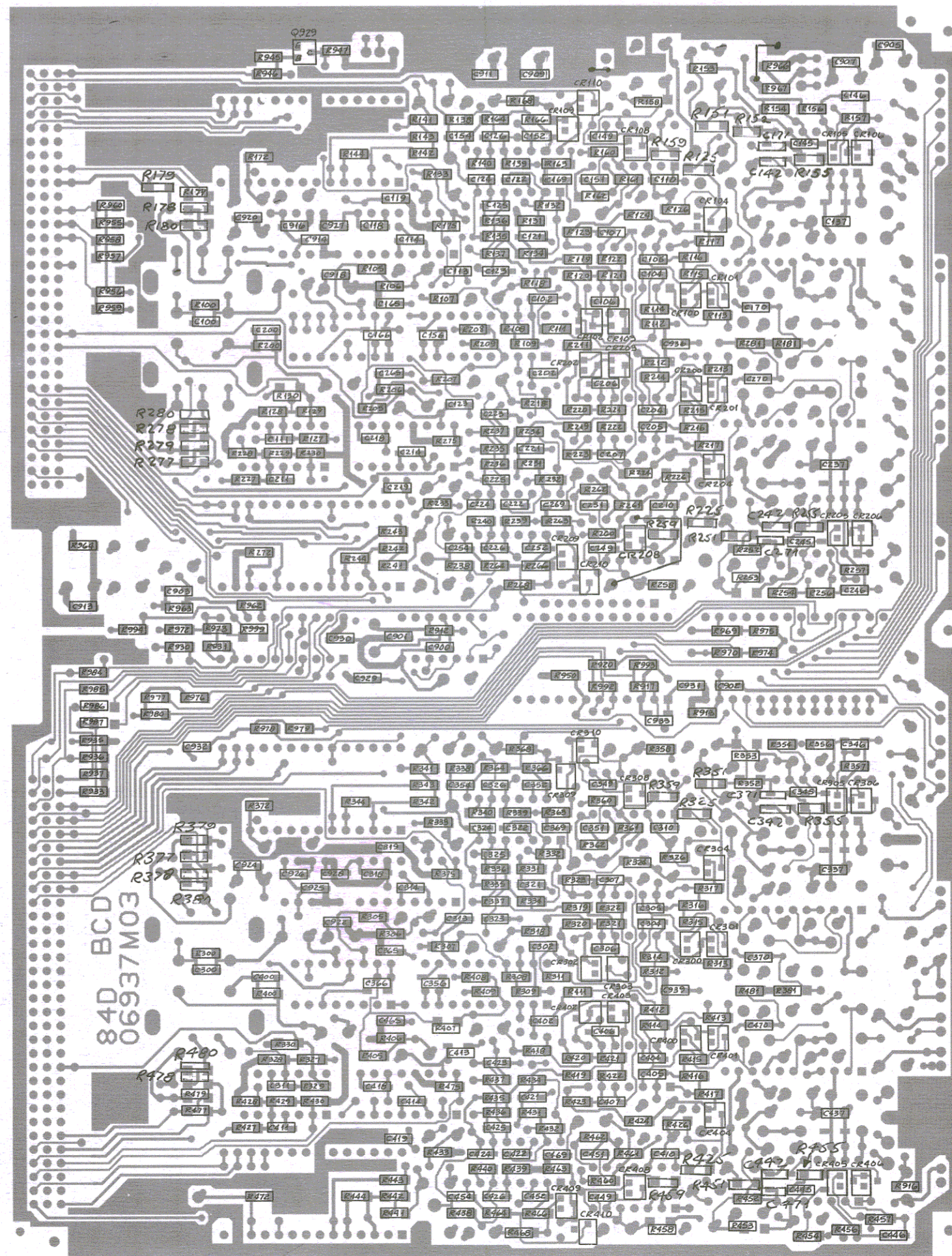
2.1 The QRN4306B Input Board is a plug-in circuit board that contains audio processing, and status and control circuitry for four channels (channels 1 to 4, or 5 to 8, depending on the location of the board in the card cage). Each of the four channels have audio line input conditioning circuitry, comparators, and analog-to-digital converters required to change the analog inputs to digital form for use by the PIAs and SSDAs on the peripheral board.

2.2 This circuitry regulates the level of the incoming signal. It determines whether the incoming signal is coded audio, clear audio, or status tone. It also determines the noise levels on the incoming clear signals and passes this information to the Peripheral board.

2.3 Controls on this board include a yellow **Unsquelled** LED, a green **Code Detect** LED, a green **Voted** LED and a red **Fail** LED. This board also includes the **Monitor/ Normal/ Disable** three-position switch. All controls are mounted on the front panel/pull handle of the board.



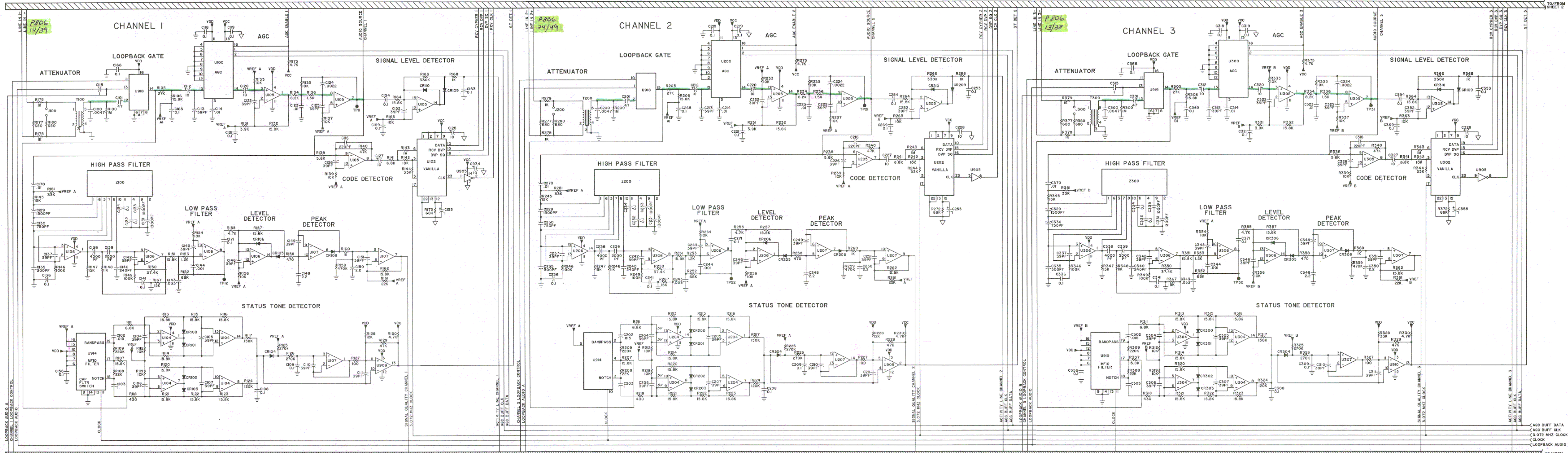
QRN4306B Input Board
Circuit Board Detail, Component Side Components
Motorola No. 31-SP5252359-4
(Sheet 1 of 2)
7/1/88

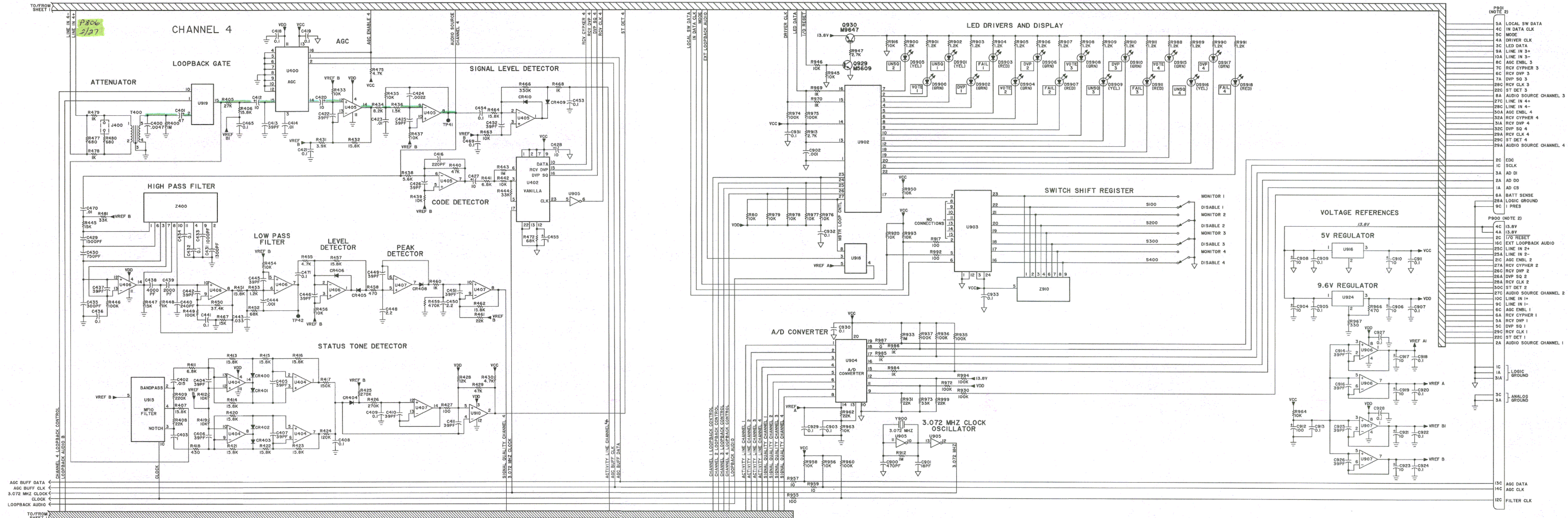


SHOWN FROM SOLDER SIDE

31-SP5252359-4
(SHEET 2 OF 2)

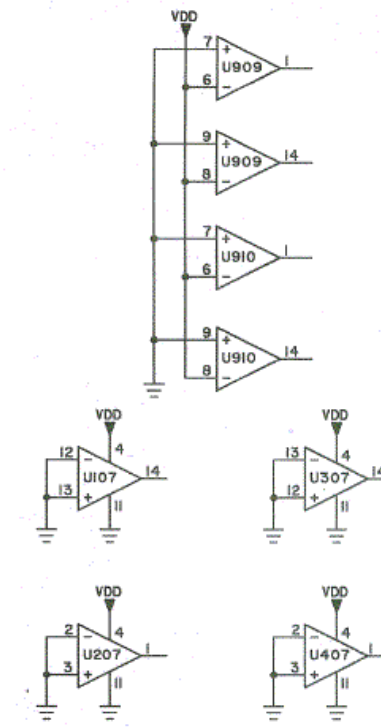
QRN4306B Input Board
Circuit Board Detail, Solder Side Components
Motorola No. 31-SP5252359-4
(Sheet 2 of 2)
7/1/88





- NOTES:
- UNLESS OTHERWISE STATED, ALL RESISTORS ARE IN OHMS, AND ALL CAPACITORS IN MICROFARADS.
 - BOTH CONNECTORS HAVE THREE ROWS OF PINS. REFER TO CIRCUIT BOARD DETAIL.
 - UPPER BUS IS USED PRIMARILY FOR CARD-EDGE CONNECTIONS ON THIS BOARD. SIGNALS COMMON TO ALL FOUR CHANNELS ARE SEPARATED FROM THESE BUSES.

UNUSED COMPONENTS



32-SP5252359-4
(SHEET 2 OF 2)

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		<u>CAPACITOR, fixed:</u> chip, uF; 50 V
C100	2111032A17	.0047 $\pm 10\%$
C101	2311019A40	47 $\pm 20\%$ 25 V
C102	2111032A23	.015 $\pm 10\%$
C103	0811044A33	1.0 $\pm 5\%$ 63 V
C104 thru C107	2111031A29	39 $\pm 5\%$
C108, C109	0811044A15	polyest 0.1 $\pm 5\%$ 63 V
C110, C111	2111031A29	39 $\pm 5\%$
C112	2311019A20	tant 10 $\pm 20\%$ 25 V
C113	2111031A29	39 $\pm 5\%$
C114	2111032A21	.01 $\pm 10\%$
C115	0811044A33	1.0 $\pm 5\%$ 63 V
C118, C119	2111032A33	0.1 $\pm 10\%$
C120	2311019A20	10 $\pm 20\%$ 25 V
C121	2111032A33	0.1 $\pm 10\%$
C122	2111031A29	39 pf $\pm 5\%$
C123	2111032A21	.01 $\pm 10\%$
C124	2111032A13	.0022 $\pm 10\%$
C125, C126	2111031A29	39 pf $\pm 5\%$
C127, C128	2311019A20	tant 10 $\pm 20\%$ 25 V
C129	2184426B73	1500 pf $\pm 2\%$ 100 V
C130	2184534B08	750 pf $\pm 2\%$ 300 V
C131	2100864736	1300 pf $\pm 5\%$ 500 V
C132	0811044A15	0.1 $\pm 5\%$ 63 V
C133	2184426B04	1000 pf $\pm 5\%$ 100 V
C134	0811044A15	0.1 $\pm 5\%$ 63 V
C135	2183003G05	300 pf $\pm 2\%$ 100 V
C136	0811044A15	0.1 $\pm 5\%$ 63 V
C137	2111031A29	39 pf $\pm 5\%$
C138	2100863396	4000 pf $\pm 1\%$ 500 V
C139	2100863293	2000 pf $\pm 2\%$ 500 V
C140	2100840048	240 pf $\pm 5\%$ 500 V
C141	0811044A15	0.1 $\pm 5\%$ 63 V
C142	2111031A29	39 $\pm 5\%$
C143	0811044A11	polyest .033 $\pm 5\%$ 63 V
C144	0811051A01	polyest .001 $\pm 5\%$
C145, C146	2111031A29	39 pf $\pm 5\%$
C148	2311019A11	2.2 uF $\pm 20\%$
C149	2111031A29	39 $\pm 5\%$
C150	2311019A11	2.2 uF $\pm 20\%$
C151, C152	2111031A29	39 pf $\pm 5\%$
C153	0811044A15	.1 uF $\pm 5\%$ 63 V
C154	2111032A33	.1 $\pm 10\%$
C155	0811044A33	1 $\pm 5\%$ 63 V
C156	2111032A33	0.1 $\pm 10\%$
C165, C166	2111032A33	0.1 $\pm 10\%$
C169	2111032A33	0.1 $\pm 10\%$

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C170	2111032A21	.01 $\pm 10\%$
C171	2111032A33	0.1 $\pm 10\%$
C200	2111032A17	.0047 $\pm 10\%$
C201	2311019A40	47 $\pm 20\%$ 25 V
C202	2111032A23	.015 $\pm 10\%$
C203	0811044A33	1.0 $\pm 5\%$ 63 V
C204 thru C207	2111031A29	39 $\pm 5\%$
C208, C209	0811044A15	polyest 0.1 $\pm 5\%$ 63 V
C210, C211	2111031A29	39 $\pm 5\%$
C212	2311019A20	tant 10 $\pm 20\%$ 25 V
C213	2111031A29	39 $\pm 5\%$
C214	2111032A21	.01 $\pm 10\%$
C218, C219	0811044A33	1.0 $\pm 5\%$ 63 V
C220	2111032A33	0.1 $\pm 10\%$
C221	2311019A20	10 $\pm 20\%$ 25 V
C222	2111032A33	0.1 $\pm 10\%$
C223	2111031A29	39 pf $\pm 5\%$
C224	2111032A21	.01 $\pm 10\%$
C225, C226	2111032A13	.0022 $\pm 10\%$
C227, C228	2111031A29	39 pf $\pm 5\%$
C229	2311019A20	tant 10 $\pm 20\%$ 25 V
C230	2184426B73	1500 pf $\pm 2\%$ 100 V
C231	2184534B08	750 pf $\pm 2\%$ 300 V
C232	2100864736	1300 pf $\pm 5\%$ 500 V
C233	0811044A15	0.1 $\pm 5\%$ 63 V
C234	2184426B04	1000 pf $\pm 5\%$ 100 V
C235	0811044A15	0.1 $\pm 5\%$ 63 V
C236	2183003G05	300 pf $\pm 2\%$ 100 V
C237	0811044A15	0.1 $\pm 5\%$ 63 V
C238	2111031A29	39 pf $\pm 5\%$
C239	2100863396	4000 pf $\pm 1\%$ 500 V
C240	2100863293	2000 pf $\pm 2\%$ 500 V
C241	2100840048	240 pf $\pm 5\%$ 500 V
C242	0811044A15	0.1 $\pm 5\%$ 63 V
C243	2111031A29	39 $\pm 5\%$
C244	0811044A11	polyest .033 $\pm 5\%$ 63 V
C245, C246	0811051A01	polyest .001 $\pm 5\%$
C248	2111031A29	39 pf $\pm 5\%$
C249	2311019A11	2.2 uF $\pm 20\%$
C250	2311019A11	2.2 uF $\pm 20\%$
C251, C252	2111031A29	39 pf $\pm 5\%$
C253	0811044A15	.1 uF $\pm 5\%$ 63 V
C254	2111032A33	.1 $\pm 10\%$
C255	0811044A33	1 $\pm 5\%$ 63 V
C256	2111032A33	0.1 $\pm 10\%$
C265, 266	2111032A33	0.1 $\pm 10\%$
C269	2111032A33	0.1 $\pm 10\%$
C270	2111032A21	.01 $\pm 10\%$
C271	2111032A33	0.1 $\pm 10\%$

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C300	2111032A17	.0047 $\pm 10\%$
C301	2311019A40	47 $\pm 20\%$ 25 V
C302	2111032A23	.015 $\pm 10\%$
C303	0811044A33	1.0 $\pm 5\%$ 63 V
C304 thru C307	2111031A29	39 $\pm 5\%$
C308, C309	0811044A15	polyest 0.1 $\pm 5\%$ 63 V
C310, C311	2111031A29	39 $\pm 5\%$
C312	2311019A20	tant 10 $\pm 20\%$ 25 V
C313	2111031A29	39 $\pm 5\%$
C314	2111032A21	.01 $\pm 10\%$
C315	0811044A33	1.0 $\pm 5\%$ 63 V
C318, C319	2111032A33	0.1 $\pm 10\%$
C320	2311019A20	10 $\pm 20\%$ 25 V
C321	2111032A33	0.1 $\pm 10\%$
C322	2111031A29	39 pf $\pm 5\%$
C323	2111032A21	.01 $\pm 10\%$
C324	2111032A13	.0022 $\pm 10\%$
C325, C326	2111031A29	39 pf $\pm 5\%$
C327, C328	2311019A20	tant 10 $\pm 20\%$ 25 V
C329	2184426B73	1500 pf $\pm 2\%$ 100 V
C330	2184534B08	750 pf $\pm 2\%$ 300 V
C331	2100864736	1300 pf $\pm 5\%$ 500 V
C332	0811044A15	0.1 $\pm 5\%$ 63 V
C333	2184426B04	1000 pf $\pm 5\%$ 100 V
C334	0811044A15	0.1 $\pm 5\%$ 63 V
C335	2183003G05	300 pf $\pm 2\%$ 100 V
C336	0811044A15	0.1 $\pm 5\%$ 63 V
C337	2111031A29	39 pf $\pm 5\%$
C338	2100863396	4000 pf $\pm 1\%$ 500 V
C339	2100863293	2000 pf $\pm 2\%$ 500 V
C340	2100840048	240 pf $\pm 5\%$ 500 V
C341	0811044A15	0.1 $\pm 5\%$ 63 V
C342	2111031A29	39 $\pm 5\%$
C343	0811044A11	polyest .033 $\pm 5\%$ 63 V
C344	2111032A17	.0047 $\pm 10\%$
C345, C346	0811051A01	polyest .001 $\pm 5\%$
C348	2111031A29	39 pf $\pm 5\%$
C349	2311019A11	2.2 uF $\pm 20\%$
C350	2311019A11	2.2 uF $\pm 20\%$
C351, C352	2111031A29	39 pf $\pm 5\%$
C353	0811044A15	.1 uF $\pm 5\%$ 63 V
C354	2111032A33	.1 $\pm 10\%$
C355	0811044A33	1 $\pm 5\%$ 63 V
C356	2111032A33	0.1 $\pm 10\%$
C365, C366	2111032A33	0.1 $\pm 10\%$
C369	2111032A33	0.1 $\pm 10\%$
C370	2111032A21	.01 $\pm 10\%$
C371	2111032A33	0.1 $\pm 10\%$

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C400	2111032A17	.0047 $\pm 10\%$
C401	2311019A40	47 $\pm 20\%$ 25 V
C402	2111032A23	.015 $\pm 10\%$
C403	0811044A33	1.0 $\pm 5\%$ 63 V
C404 thru C407	2111031A29	39 $\pm 5\%$
C408, C409	0811044A15	polyest 0.1 $\pm 5\%$ 63 V
C410, C411	2111031A29	39 $\pm 5\%$
C412	2311019A20	tant 10 $\pm 20\%$ 25 V
C413	2111031A29	39 $\pm 5\%$
C414	2111032A21	.01 $\pm 10\%$
C418	0811044A33	1.0 $\pm 5\%$ 63 V
C419	2111032A33	0.1 $\pm 10\%$
C420	2311019A20	10 $\pm 20\%$ 25 V
C421	2111032A33	0.1 $\pm 10\%$
C422	2111031A29	39 pf $\pm 5\%$
C423	2111032A21	.01 $\pm 10\%$
C424	2111032A13	.0022 $\pm 10\%$
C425, C426	2111031A29	39 pf $\pm 5\%$
C427, C428	2311019A20	tant 10 $\pm 20\%$ 25 V
C429	2184426B73	1500 pf $\pm 2\%$ 100 V
C430	2184534B08	750 pf $\pm 2\%$ 300 V
C431	2100864736	1300 pf $\pm 5\%$ 500 V
C432	0811044A15	0.1 $\pm 5\%$ 63 V
C433	2184426B04	1000 pf $\pm 5\%$ 100 V
C434	0811044A15	0.1 $\pm 5\%$ 63 V
C435	2183003G05	300 pf $\pm 2\%$ 100 V
C436	0811044A15	0.1 $\pm 5\%$ 63 V
C437	2111031A29	39 pf $\pm 5\%$
C438	2100863396	4000 pf $\pm 1\%$ 500 V
C439	2100863293	2000 pf $\pm 2\%$ 500 V
C440	2111032A17	.0047 $\pm 10\%$
C441	2100840048	240 pf $\pm 5\%$ 500 V
C442	0811044A15	0.1 $\pm 5\%$ 63 V
C443	2111031A29	39 $\pm 5\%$
C444	0811044A11	polyest .033 $\pm 5\%$ 63 V
C445, C446	0811051A01	polyest .001 $\pm 5\%$
C448	2111031A29	39 pf $\pm 5\%$
C449	2311019A11	2.2 uF $\pm 20\%$
C450	2311019A11	2.2 uF $\pm 20\%$
C451, C452	2111031A29	39 pf $\pm 5\%$
C453	0811044A15	.1 uF $\pm 5\%$ 63 V
C454	2111032A33	.1 $\pm 10\%$
C455	0811044A33	1 $\pm 5\%$ 63 V
C456	2111032A33	0.1 $\pm 10\%$
C465, C466	2111032A33	0.1 $\pm 10\%$
C469	2111032A33	0.1 $\pm 10\%$
C470	2111032A21	.01 $\pm 10\%$
C471	2111032A33	0.1 $\pm 10\%$

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C900	2111031A55	470 pf $\pm 5\%$
C901	2111031A21	18 pf $\pm 5\%$
C902	2111032A09	.001 $\pm 10\%$
C903	2111032A33	0.1 $\pm 10\%$
C904	2311019A20	10 $\pm 20\%$ 25 V
C905	2111032A33	0.1 $\pm 10\%$
C906	2311019A20	10 $\pm 20\%$ 25 V
C907	2111032A33	0.1 $\pm 10\%$
C908	2311019A20	10 $\pm 20\%$ 25 V
C909	2111032A33	0.1 $\pm 10\%$
C910	2311019A20	10 $\pm 20\%$ 25 V
C911	2111032A33	0.1 $\pm 10\%$
C912	2311019A46	100 $\pm 20\%$ 25 V
C913	2111032A33	0.1 $\pm 10\%$
C914	2111031A29	39 pf $\pm 5\%$
C916	2111031A29	39 pf $\pm 5\%$
C917	2311019A20	10 $\pm 20\%$ 25 V
C918	2111032A33	0.1 $\pm 10\%$
C919	2311019A20	10 $\pm 20\%$ 25 V
C920	2111032A33	0.1 $\pm 10\%$
C921	2311019A20	10 $\pm 20\%$ 25 V
C922	2111032A33	0.1 $\pm 10\%$
C923	2311019A20	10 $\pm 20\%$ 25 V
C924	2111032A33	0.1 $\pm 10\%$
C925, C926	2111031A29	39 pf $\pm 5\%$
C927 thru C933	2111032A33	0.1 $\pm 10\%$
C934	2311019A20	10 $\pm 20\%$ 25 V
C936	2111032A33	0.1 $\pm 10\%$
C939	2111032A33	0.1 $\pm 10\%$
<u>DIODE: (SEE NOTE)</u>		
CR100 thru CR106	4811058C11	silicon
CR108 thru CR110	4811058C11	silicon
CR200 thru CR206	4811058C11	silicon
CR208 thru CR210	4811058C11	silicon
CR300 thru CR306	4811058C11	silicon
CR308 thru CR310	4811058C11	silicon
CR400 thru CR406	4811058C11	silicon
CR408 thru CR410	4811058C11	silicon
<u>LIGHT EMITTING DIODE: (SEE NOTE)</u>		
DS900	4888245C22	grn
DS901	4888245C23	yel
DS902	4888245C22	grn
DS903	4888245C24	red
DS904	4888245C22	grn
DS905	4888245C23	yel
DS906	4888245C22	grn
DS907	4888245C24	red

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
DS908	4888245C22	grn
DS909	4888245C23	yel
DS910	4888245C22	grn
DS911	4888245C24	red
DS915	4888245C22	grn
DS916	4888245C23	yel
DS917	4888245C22	grn
DS918	4888245C24	red
<u>CONNECTOR, receptacle:</u>		
J100	2884729L01	2 pin code plug
J200	2884729L01	2 pin code plug
J300	2884729L01	2 pin code plug
J400	2884729L01	2 pin code plug
<u>CONNECTOR, plug:</u>		
P900, P901	0982236R01	female, 96 contact 90 degrees
<u>TRANSISTOR: (SEE NOTE)</u>		
Q929	4811056C09	NPN type M5609
Q930	4800869647	PNP type M9647
<u>RESISTOR, fixed: chip, $\pm 5\%$; 1/8 W</u> unless otherwise stated		
R100	0611077B47	1 meg
R105	0611077B09	27k
R106, R107	0611024H11	15.8k
R108	0611077B07	22k
R109	0611077B31	220k
R111	0611077A94	6.8k
R112	0611077A98	10k
R113 thru R116	0611024H11	15.8k
R117	0611077B27	150k
R118	0611077A65	430
R119	0611077A98	10k
R120 thru R123	0611024H11	15.8k
R124	0611077B25	120k
R125, R126	0611077B33	270k
R127	0611077A50	100
R128	0611077B01	12k
R129	0611077B15	47k
R130	0611077A90	4700
R131	0611077A88	3.9k
R132	0611024H11	15.8k
R133	0611077A98	10k
R134	0611077A96	8200
R135	0611077A98	10k
R136	0611077A78	1.5k

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R137	0611077A98	10k
R138	0611077A92	5600
R139	0611077A98	10k
R140	0611077B15	47k
R141	0611077A94	6800
R142	0611077A98	10k
R143	0611077B47	1 meg
R144	0611077B11	33k
R145	0611049S09	FMF 15k $\pm 1\%$ 1/4 W
R146	0611049S88	FMF 100k $\pm 1\%$ 1/4 W
R147	0611009E77	FCF 15k $\pm 5\%$ 1/4 W
R148	0611009E74	FCF 11k $\pm 5\%$ 1/4 W
R149	0611049S88	FMF 100k $\pm 1\%$ 1/4 W
R150	0611049S47	FMF 37.4k $\pm 1\%$ 1/4 W
R151	0611024H11	15.8k
R152	0611077B19	68k
R153	0611-77A76	1.2k
R154	0611077A98	10k
R155	0611077A90	4.7k
R156	0611077A98	10k
R157	0611024H11	15.8k
R158	0611077A66	470
R159	0600185B39	470k
R160	0611077A74	1000
R161	0611077B07	22k
R162	0611024H11	15.8k
R163	0611077A98	10k
R164	0611024H11	15.8k
R166	0611077B35	330k
R167	0611009E77	FCF 15k 1/4 W
R168	0611009E74	1k
R172	0611077B19	68k
R175	0611077A90	4700
R177	0611077A70	680
R178, R179	0611009E74	1k
R180	0611077A70	680
R181	0611077B11	33k
R200	0611077B47	1 meg
R205	0611077B09	27k
R206, R207	0611024H11	15.8k
R208	0611077B07	22k
R209	0611077B31	220k
R211	0611077A94	6.8k
R212	0611077A98	10k
R213 thru R216	0611024H11	15.8k
R217	0611077B27	150k
R218	0611077A65	430
R219	0611077A98	10k

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R220 thru R223	0611024H11	15.8k
R224	0611077B25	120k
R225, R226	0611077B33	270k
R227	0611077A50	100
R228	0611077B01	12k
R229	0611077B15	47k
R230	0611077A90	4700
R231	0611077A88	3.9k
R232	0611024H11	15.8k
R233	0611077A98	10k
R234	0611077A96	8200
R235	0611077A98	10k
R236	0611077A78	1.5k
R237	0611077A98	10k
R238	0611077A92	5600
R239	0611077A98	10k
R240	0611077B15	47k
R241	0611077A94	6800
R242	0611077A98	10k
R243	0611077B47	1 meg
R244	0611077B11	33k
R245	0611049S09	FMF 15k $\pm 1\%$ 1/4 W
R246	0611049S88	FMF 100k $\pm 1\%$ 1/4 W
R247	0611009E77	FCF 15k $\pm 5\%$ 1/4 W
R248	0611009E74	FCF 11k $\pm 5\%$ 1/4 W
R249	0611049S88	FMF 100k $\pm 1\%$ 1/4 W
R250	0611049S47	FMF 37.4k $\pm 1\%$ 1/4 W
R251	0611024H11	15.8k
R252	0611077B19	68k
R253	0611-77A76	1.2k
R254	0611077A98	10k
R255	0611077A90	4.7k
R256	0611077A98	10k
R257	0611024H11	15.8k
R258	0611077A66	470
R259	0600185B39	470k
R260	0611077A74	1000
R261	0611077B07	22k
R262	0611024H11	15.8k
R263	0611077A98	10k
R264	0611024H11	15.8k
R266	0611077B35	330k
R267	0611009E77	FCF 15k 1/4 W
R268	0611009E74	1k
R272	0611077B19	68k
R275	0611077A90	4700
R277	0611077A70	680
R278, R279	0611009E74	1k

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R280	0611077A70	680
R281	0611077B11	33k
R300	0611077B47	1 meg
R305	0611077B09	27k
R306, R307	0611024H11	15.8k
R308	0611077B07	22k
R309	0611077B31	220k
R311	0611077A94	6.8k
R312	0611077A98	10k
R313 thru R316	0611024H11	15.8k
R317	0611077B27	150k
R318	0611077A65	430
R319	0611077A98	10k
R320 thru R323	0611024H11	15.8k
R324	0611077B25	120k
R325, R326	0611077B33	270k
R327	0611077A50	100
R328	0611077B01	12k
R329	0611077B15	47k
R330	0611077A90	4700
R331	0611077A88	3.9k
R332	0611024H11	15.8k
R333	0611077A98	10k
R334	0611077A96	8200
R335	0611077A98	10k
R336	0611077A78	1.5k
R337	0611077A98	10k
R338	0611077A92	5600
R339	0611077A98	10k
R340	0611077B15	47k
R341	0611077A94	6800
R342	0611077A98	10k
R343	0611077B47	1 meg
R344	0611077B11	33k
R345	0611049S09	FMF 15k $\pm 1\%$ 1/4 W
R346	0611049S88	FMF 100k $\pm 1\%$ 1/4 W
R347	0611009E77	FCF 15k $\pm 5\%$ 1/4 W
R348	0611009E74	FCF 11k $\pm 5\%$ 1/4 W
R349	0611049S88	FMF 100k $\pm 1\%$ 1/4 W
R350	0611049S47	FMF 37.4k $\pm 1\%$ 1/4 W
R351	0611024H11	15.8k
R352	0611077B19	68k
R353	0611-77A76	1.2k
R354	0611077A98	10k
R355	0611077A90	4.7k
R356	0611077A98	10k
R357	0611024H11	15.8k
R358	0611077A66	470

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R359	0600185B39	470k
R360	0611077A74	1000
R361	0611077B07	22k
R362	0611024H11	15.8k
R363	0611077A98	10k
R364	0611024H11	15.8k
R366	0611077B35	330k
R367	0611009E77	FCF 15k 1/4 W
R368	0611009E74	1k
R372	0611077B19	68k
R375	0611077A90	4700
R377	0611077A70	680
R378, R179	0611009E74	1k
R380	0611077A70	680
R381	0611077B11	33k
R400	0611077B47	1 meg
R405	0611077B09	27k
R406, R407	0611024H11	15.8k
R408	0611077B07	22k
R409	0611077B31	220k
R411	0611077A94	6.8k
R412	0611077A98	10k
R413 thru R416	0611024H11	15.8k
R417	0611077B27	150k
R418	0611077A65	430
R419	0611077A98	10k
R420 thru R423	0611024H11	15.8k
R424	0611077B25	120k
R425, R426	0611077B33	270k
R427	0611077A50	100
R428	0611077B01	12k
R429	0611077B15	47k
R430	0611077A90	4700
R431	0611077A88	3.9k
R432	0611024H11	15.8k
R433	0611077A98	10k
R434	0611077A96	8200
R435	0611077A98	10k
R436	0611077A78	1.5k
R437	0611077A98	10k
R438	0611077A92	5600
R439	0611077A98	10k
R440	0611077B15	47k
R441	0611077A94	6800
R442	0611077A98	10k
R443	0611077B47	1 meg
R444	0611077B11	33k
R445	0611049S09	FMF 15k $\pm 1\%$ 1/4 W

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R446	0611049S88	FMF 100k $\pm 1\%$ 1/4 W
R447	0611009E77	FCF 15k $\pm 5\%$ 1/4 W
R448	0611009E74	FCF 11k $\pm 5\%$ 1/4 W
R449	0611049S88	FMF 100k $\pm 1\%$ 1/4 W
R450	0611049S47	FMF 37.4k $\pm 1\%$ 1/4 W
R451	0611024H11	15.8k
R452	0611077B19	68k
R453	0611-77A76	1.2k
R454	0611077A98	10k
R455	0611077A90	4.7k
R456	0611077A98	10k
R457	0611024H11	15.8k
R458	0611077A66	470
R459	0600185B39	470k
R460	0611077A74	1000
R461	0611077B07	22k
R462	0611024H11	15.8k
R463	0611077A98	10k
R464	0611024H11	15.8k
R466	0611077B35	330k
R467	0611009E77	FCF 15k 1/4 W
R468	0611009E74	1k
R472	0611077B19	68k
R475	0611077A90	4700
R477	0611077A70	680
R478, R479	0611009E74	1k
R480	0611077A70	680
R481	0611077B11	33k
R900 thru R911	0611009E51	FCF 1200 1/4 W
R912	0611077B47	1 meg
R913	0611077A84	2700
R916	0611077A98	10k
R917	0611077A50	100
R920	0611077A98	10k
R930	0611077B23	100k
R931	0611077B07	22k
R933	0611077B47	1 meg
R935 thru R937	0611077B23	100k
R945, R946	0611077A98	10k
R947	0611077A84	2700
R950	0611077A98	10k
R955	0611077A50	100
R956	0611077A98	10k
R957	0611077A26	10
R958	0611077A98	10k
R959	0611077A26	10
R960	0611077B23	100k
R962	0611077B07	22k

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R963, R964	0611077A98	10k
R966	0611077A66	470
R967	0611077A62	330
R969, R970	0611077A74	1000
R972	0611077B23	100k
R973	0611077B11	33k
R974, R975	0611077B23	100k
R976 thru R980	0611077A98	10k
R984 thru R986	0611077A74	1000
R987	0611077A01	jumper, 0 ohms
R988 thru R986	0611009E51	FCF 1200 1/4 W
R992	0611077A50	100
R993	0611077A98	10k
R994	0611077B23	100k
R999	0611077B07	22k
<u>SWITCH</u> , toggle:		
S100	4083249K12	sp3t
S200	4083249K12	sp3t
S300	4083249K12	sp3t
S400	4083249K12	sp3t
<u>TRANSFORMER</u> :		
T100	2584007C02	audio
T200	2584007C02	audio
T300	2584007C02	audio
T400	2584007C02	audio
<u>TEST POINT</u> :		
TP11, TP12	2910271A15	terminal, pin
TP21, TP22	2910271A15	terminal, pin
TP31, TP32	2910271A15	terminal, pin
TP41, TP42	2910271A15	terminal, pin
<u>INTEGRATED CIRCUIT</u> : (SEE NOTE)		
U100	5183977M60	digital volume control
U102	5183977M38	custom ic base
U104 thru U107	5183222M95	quad operational amplifier
U200	5183977M60	digital volume control
U202	5183977M38	custom ic base
U204 thru U207	5183222M95	quad operational amplifier
U300	5183977M60	digital volume control
U302	5183977M38	custom ic base
U304 thru U307	5183222M95	quad operational amplifier
U400	5183977M60	digital volume control
U402	5183977M38	custom ic base
U404 thru U407	5183222M95	quad operational amplifier

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
U902	5180135C08	3 1/2 digit LED display driver
U903	5106472A86	16 bit shift register
U904	5184174P71	8 bit A/D converter
U905	5106472A85	inverter
U906, U907	5184621K89	quad operational amplifier
U909, U910	5184621K11	comparator dual
U914, U915	5183529M76	dual capacitor filter switch
U916	5184320A47	regulator voltage +5V 750ma
U918, U919	5184887K60	2-channel analog mux/demux
U924	5184320A47	voltage regulator +5V 750ma
<u>CRYSTAL:</u>		
Y900	4882611M12	oscillator 3.072 MHz
<u>HYBRID:</u>		
Z100	0180789B93	resistor module
Z200	0180789B93	resistor module
Z300	0180789B93	resistor module
Z400	0180789B93	resistor module
Z910	5182142K15	resistor network
<u>NON-REFERENCED ITEMS:</u>		
	0982808R09	socket IC: 24 contact
	0984728L01	socket, connector; 4 used
	0200120487	nut, hex: 2-56 x 3/16 x 1/16"; 4 used
	0382009T01	screw, tapping: 2-56 x 1/2"; 4 used
	0310943J14	screw, tapping: TT3.5 x 0.6 x 6mm; 3 used
	0400009777	washer, lock: #2 split; 4 used
	6406418N01	panel, front input
	7505295B01	pad, crystal base
	0210239A03	nut, nylon: 4-40 x .25 x .098; 2 used
	0310129A07	screw, nylon: 4-40 x .25 x .098; 2 used
	1483820M02	insulator, heat conductor; 2 used
	2682271P01	heat sink; 2 used
	0982808R03	socket, 14-contact; 2 used
		socket, 16-contact; 4 used
		insert, threaded; metric; 4 used

NOTE: For optimum performance, diodes, transistors, crystals, and integrated circuits must be ordered by Motorola part numbers.



OUTPUT BOARD

INSTRUCTION SECTION

MODEL QRN4307B

1. ATTACHMENTS

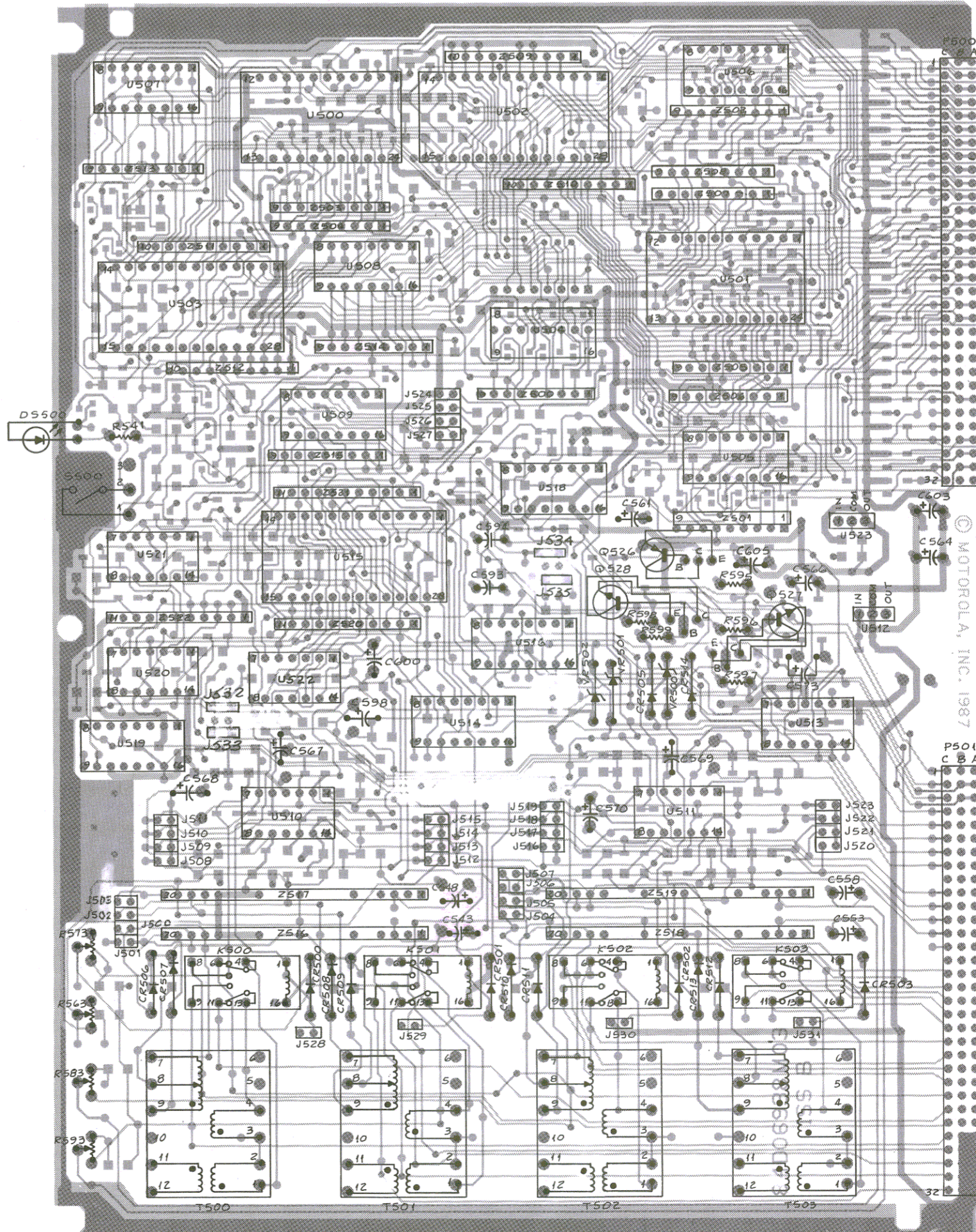
-- QRN4307B Output Board Circuit Board Detail (component side)	36-SP5252359-1
-- QRN4307B Output Board Circuit Board Detail (solder side)	36-SP5252359-2
-- QRN4307B Output Board Schematic Diagram (sheet 1)	37-SP5252359-1
-- QRN4307B Output Board Schematic Diagram (sheet 2)	37-SP5252359-2
-- QRN4307B Output Board Schematic Diagram (sheet 3)	37-SP5252359-3
-- QRN4307B Output Board Parts List	38PL-SP5252359

2. DESCRIPTION

2.1 The QRN4305B Input Board is a plug-in circuit board that contains all the outgoing audio processing circuitry for the comparator. This circuitry includes all the output conditioning circuitry and audio line drivers to match the audio output to a 600-ohm line.

2.2 The output board conditions the incoming receiver signal that the microprocessor has chosen to apply to the comparator output. It also contains four line drivers and jumpers which connect the internal audio buses to the external line outputs.

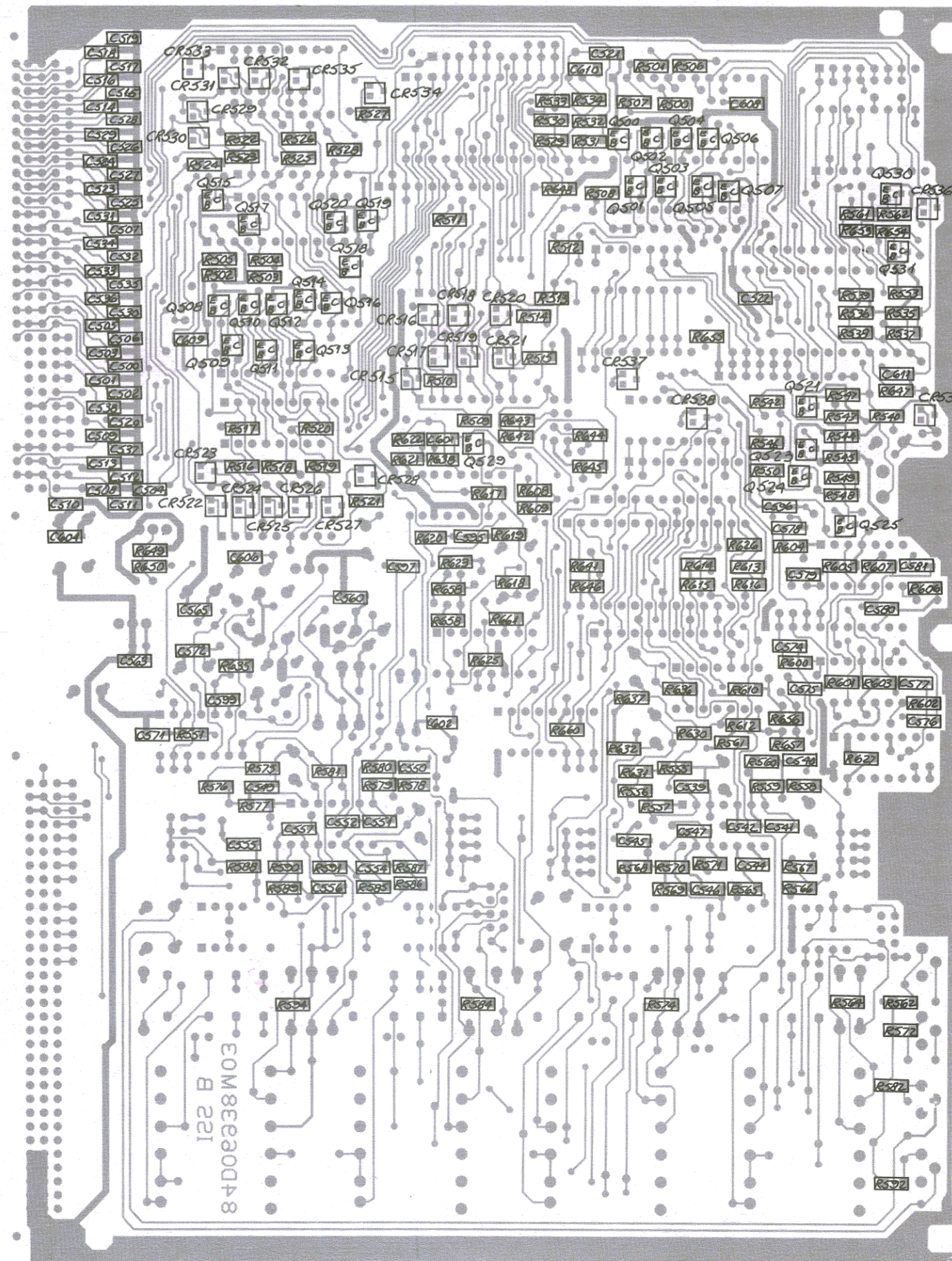
2.3 Controls on this board include the red **Standby** LED, the **Standby/Normal** select switch and a **LD Level Adj** potentiometer for each of the four channels. All controls are mounted on the front panel/pull handle of the board.



QRN4307B Output Board
Circuit Board Details
Motorola No. 36-SP5252359-3
(Sheet 1 of 2)
7/5/88

36-SP5252359-3
(SHEET 1 OF 2)

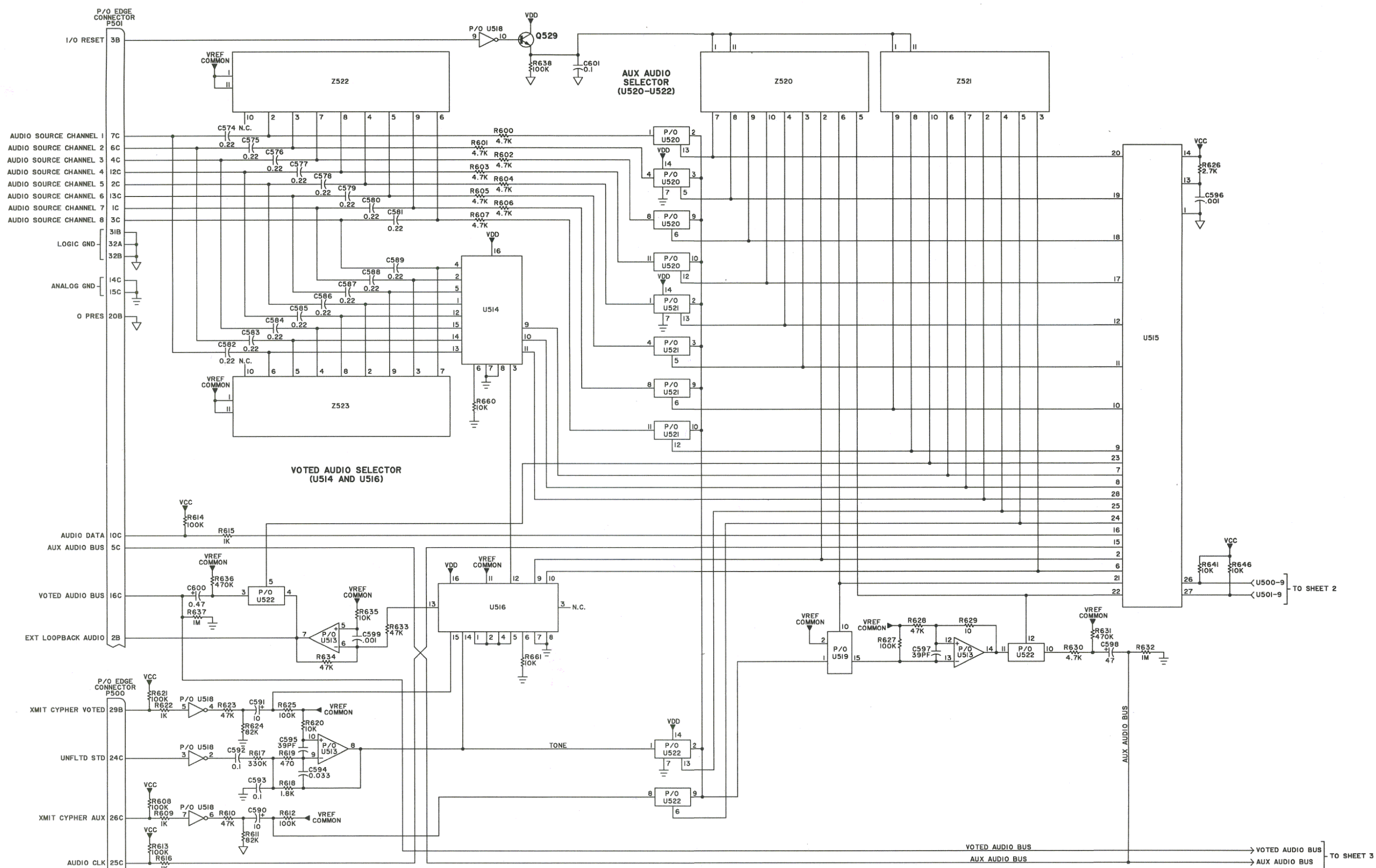
SHOWN FROM COMPONENT SIDE

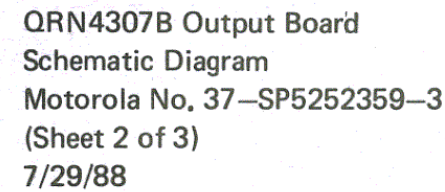


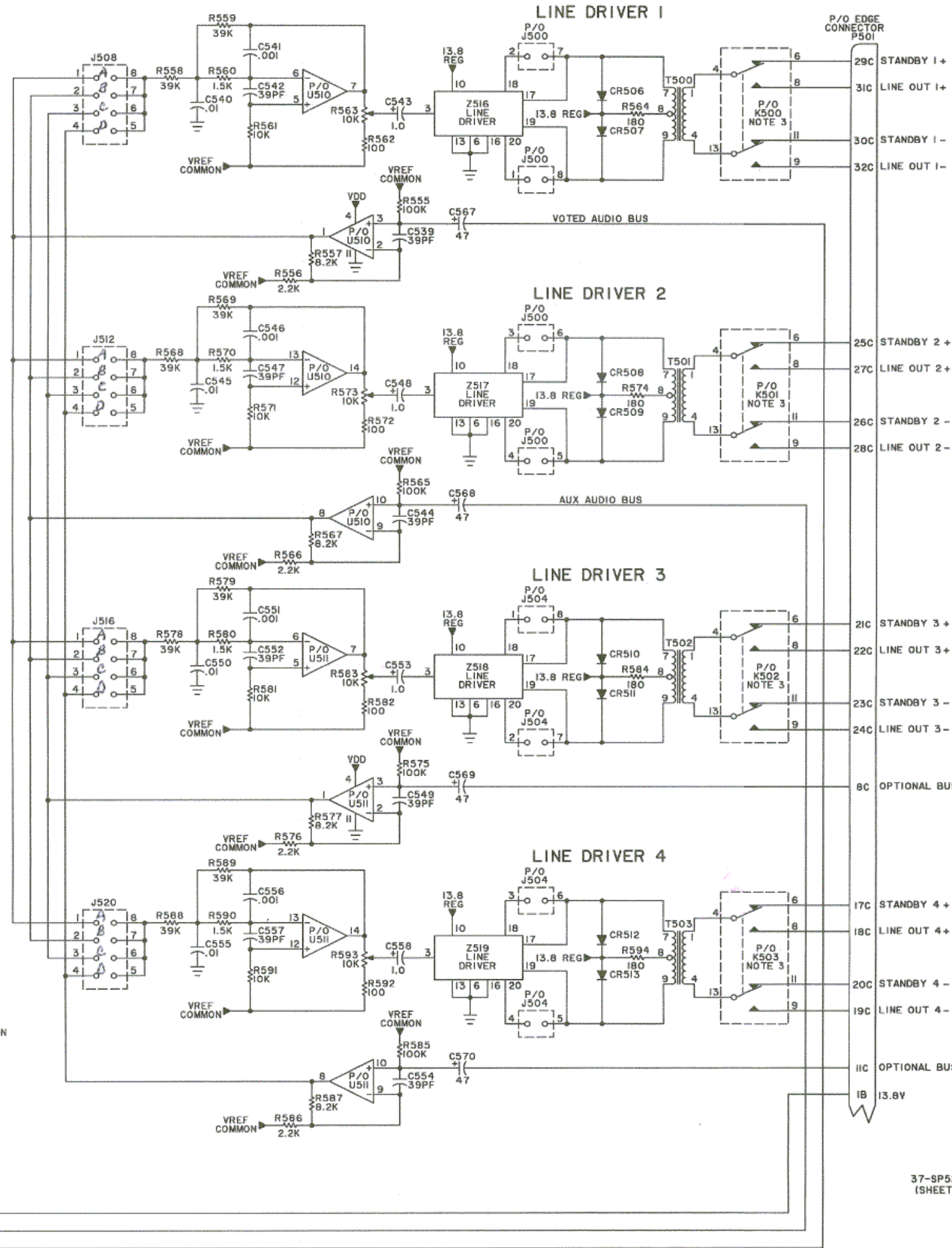
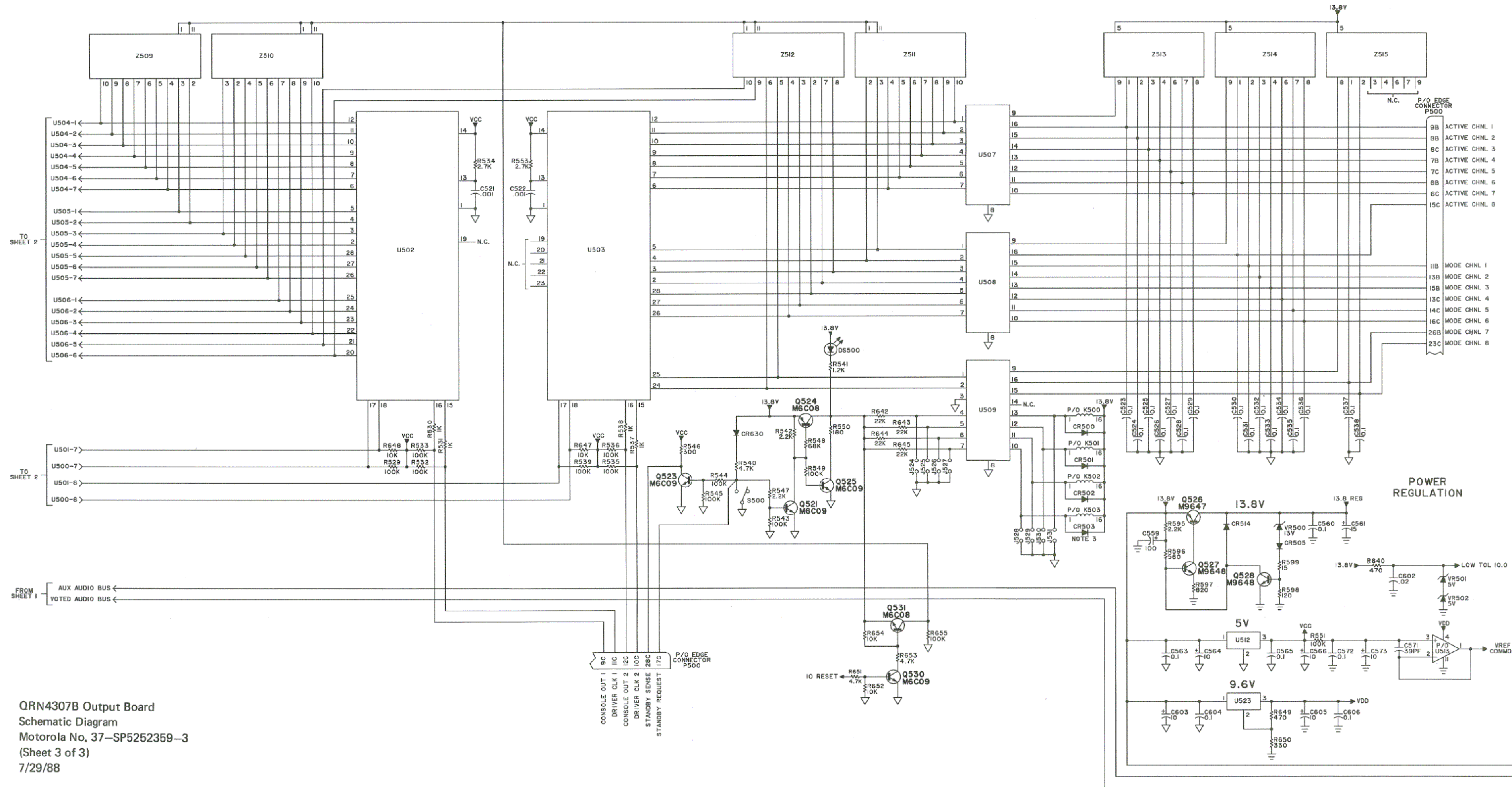
SHOWN FROM SOLDER SIDE

36-SP5252359-3
(SHEET 2 OF 2)

QRN4307B Output Board
Circuit Board Details
Motorola No. 36-SP5252359-3
(Sheet 2 of 2)
7/5/88

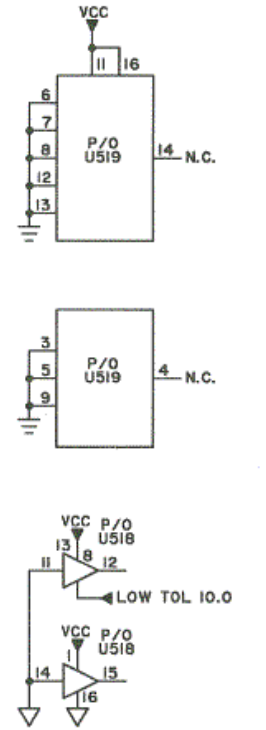






1. UNLESS OTHERWISE SPECIFIED, ALL RESISTORS ARE IN OHMS AND ALL CAPACITORS ARE IN MICROFARADS.
2. CONNECTORS P500 AND P501 HAVE THREE ROWS OF PINS. REFER TO CIRCUIT BOARD DETAIL.
3. RELAYS K500-K503 ARE SPLIT FOR CLARITY. RELAY COILS ARE LOCATED NEAR U505. RELAY CONTACTS ARE LOCATED NEAR THE FOUR LINE DRIVERS.
4. N.C. DENOTES NO CONNECTION.

UNUSED COMPONENTS



PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		<u>CAPACITOR, fixed:</u> chip, uF; 50 V
C500 thru C520	2111032A33	0.10 $\pm 10\%$
C521, C522	2111032A09	.001 $\pm 10\%$
C523 thru C538	2111032A33	0.1 $\pm 10\%$
C539	2111031A29	39 pf $\pm 5\%$
C540	2111032A21	0.01 $\pm 10\%$
C541	2111032A09	.001 $\pm 10\%$
C542	2111031A29	39 pf $\pm 5\%$
C543	2311019A09	alu 1.0 $\pm 20\%$
C544	2111031A29	39 pf $\pm 5\%$
C545	2111032A21	0.01 $\pm 10\%$
C546	2111032A09	.001 $\pm 10\%$
C547	2111031A29	39 pf $\pm 5\%$
C548	2311019A09	alu 1.0 $\pm 20\%$
C549	2111031A29	39 pf $\pm 5\%$
C550	2111032A21	0.01 $\pm 10\%$
C551	2111032A09	.001 $\pm 10\%$
C552	2111031A29	39 pf $\pm 5\%$
C553	2311019A09	alu 1.0 $\pm 20\%$
C554	2111031A29	39 pf $\pm 5\%$
C555	2111032A21	0.01 $\pm 10\%$
C556	2111032A09	.001 $\pm 10\%$
C557	2111031A29	39 pf $\pm 5\%$
C558	2311019A09	alu 1.0 $\pm 20\%$
C559	2311019A46	100 uF $\pm 20\%$ 25 V
C560	2111032A33	0.10 $\pm 10\%$
C561	2311019A20	10 $\pm 20\%$ 20 V
C563	2111032A33	0.10 $\pm 10\%$
C564	2311019A20	10 $\pm 20\%$ 20 V
C565	2111032A33	0.10 $\pm 10\%$
C566	2311019A20	10 $\pm 20\%$ 20 V
C567 thru C570	2384519A40	47 $\pm 20\%$ 20 V
C571	2111031A29	39 pf $\pm 5\%$
C572	2111032A33	0.10 $\pm 10\%$
C573	2311019A20	10 $\pm 20\%$ 20 V
C574 thru C581	2111032A33	.1 uF $+80\%$ -20%
C593	0811044A15	polyest 0.1 $\pm 5\%$
C594	0811044A11	polyest .033 $\pm 5\%$
C595	2111031A29	39 pf $\pm 5\%$
C596	2111032A09	.001 $\pm 10\%$
C597	2111031A29	39 pf $\pm 5\%$
C598	2384519A40	47 $\pm 20\%$ 20 V
C599	2111031A29	39 pf $\pm 5\%$
C600	2384519A40	47 $\pm 20\%$ 20 V
C601, C602	2111032A33	0.10 $\pm 10\%$
C603	2311019A20	10 $\pm 20\%$ 20 V
C604	2111032A33	0.10 $\pm 10\%$

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C605	2311019A20	10 \pm 20% 20 V
C606	2111032A33	0.10 \pm 10%
C607	2311019A46	100 μ F \pm 20% 25 V
C608 thru C611	2111032A33	0.10 \pm 10%
CR500 thru CR514	4811034A01	<u>DIODE</u> : (SEE NOTE) silicon
CR515 thru CR539	4811058A11	chip diode
J500	2884528K05	<u>CONNECTOR, receptacle</u> : male, 8 contact
J504	2884528K05	male, 8 contact
J508	2884528K05	male, 8 contact
J512	2884528K05	male, 8 contact
J516	2884528K05	male, 8 contact
J520	2884528K05	male, 8 contact
J524	2884528K05	male, 8 contact
J528	2884528K05	male, 8 contact
J500 thru J508	0984728L01	<u>CONNECTOR, socket</u> : female, 2-contact
J512, J516, J520	0984728L01	female, 2-contact
J532 thru J535	2884729L01	2 pin jumper
K500 thru K503	8084090N03	<u>RELAY, plug-in</u> : 2 amp, 12 V DC
P500	0982236R01	<u>CONNECTOR, plug</u> : female, 96 contact 90 degrees
P501	0982236R01	female, 96 contact 90 degrees
Q500 thru Q521	4811056C09	<u>TRANSISTOR</u> : (SEE NOTE) NPN, type M5609
Q523	4811056C09	NPN, type M5609
Q524	4811056C08	NPN, type M5608
Q525	4811056C09	NPN, type M5609
Q526	4800869647	PNP, type M9647
Q527, Q528	4811043A07	NPN, type M9648
Q529, Q530	4811056C09	NPN, type M5609
Q531	4811056C08	NPN, type M5608
R500 thru R503	0611077A98	<u>RESISTOR, fixed</u> : chip, \pm 5%; 1/4 W 10k
R504 thru R507	0611077A50	100
R508 thru R528	0611077B15	47k
R529	0611077B23	100k
R530, R531	0611077A74	1000

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R532, R533	0611077B23	100k
R534	0611077A84	2700
R535, R536	0611077B23	100k
R537, R538	0611077A74	1000
R539	0611077B23	100k
R540	0611077A90	4700
R541	0611009E51	FCF 1200 $\pm 5\%$ 1/4 W
R542 thru R545	0611077A82	2.2k
R546	0611077A61	300
R547	0611077B07	22k
R548	0611077B19	68k
R549	0611077B23	100k
R550	0611077A56	180
R551	0611077A98	10k
R553	0611077A84	2700
R555	0611077B23	100k
R556	0611077A82	2200
R557	0611077A96	8200
R558, R559	0611077B13	39k
R560	0611077A78	1500
R561	0611077A98	10k
R562	0611077A50	100
R563	1883452f32	variable 10k $\pm 10\%$ 1/2 W
R564	0611077A56	180
R565	0611077B23	100k
R566	0611077A82	2200
R567	0611077A96	8200
R568, R569	0611077B13	39k
R570	0611077A78	1500
R571	0611077A98	10k
R572	0611077A50	100
R573	1883452f32	variable 10k $\pm 10\%$ 1/2 W
R574	0611077A56	180
R575	0611077B23	100k
R576	0611077A82	2200
R577	0611077A96	8200
R578, R579	0611077B13	39k
R580	0611077A78	1500
R581	0611077A98	10k
R582	0611077A50	100
R583	1883452f32	variable 10k $\pm 10\%$ 1/2 W
R584	0611077A56	180
R585	0611077B23	100k
R586	0611077A82	2200
R587	0611077A96	8200
R588, R589	0611077B13	39k
R590	0611077A78	1500
R591	0611077A98	10k

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R592	0611077A50	100
R593	1883452f32	variable 10k $\pm 10\%$ 1/2 W
R594	0611077A56	180
R595	0611009E57	FCF 2200 1/4 W
R596	0611099E43	FCF 560 1/4 W
R597	0611009E47	FCF 820 1/4 W
R598	0611009E27	FCF 120 1/4 W
R599	0611009E05	FCF 15 1/4 W
R600 thru R607	0611077B15	47k
R608	0611077B23	100k
R609	0611077A74	1000
R610	0611077B22	91k
R612	0611077A82	2.2k
R613, R614	0611077B23	100k
R615, R616	0611077A74	1000
R617	0611007B35	330k
R618	0611007A80	1800
R619	0611077A66	470
R620	0611077A98	10k
R621	0611077B23	100k
R622	0611077A74	1000
R623	0611077B22	91k
R625	0611077A82	2.2k
R626	0611077A84	2700
R627	0611077B23	100k
R630	0611077A90	4700
R631	0611077B39	470k
R632	0611077B49	1 meg
R635	0611077A98	10k
R636	0611077B39	470k
R637	0611077B49	1 meg
R638	0611077B23	100k
R640	0611077A66	470
R641	0611077A98	10k
R642 thru R645	0611077B07	22k
R646, R647, R648	0611077A98	10k
R649	0611077A66	470
R650	0611077A62	330
R651	0611077A90	4.7k
R652	0611077A98	10k
R653	0611077A90	4.7k
R654	0611077A98	10k
R655, R656	0611077B23	100k
R657	0611077B31	220k
R658	0611077B23	100k
R659	0611077B31	220k
R660, R661	0611077A98	10k

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
S500	4083249K13	<u>SWITCH, toggle:</u> spdt
T500 thru T503	2583036L01	<u>TRANSFORMER:</u> audio
U500, U501	5182798R48	<u>INTEGRATED CIRCUIT:</u> (SEE NOTE) 16 bit shift register
U502, U503	5180135C08	3 1/2 digit LED display driver
U504 thru U509	5183222M75	interface 5 V log to LED display
U510, U511	5183222M95	quad operational amplifier
U512	5184320A47	+5 V voltage regulator
U513	5183222M95	quad operational amplifier
U514	5184887K26	analog mux/demux
U515	5180135C08	3 1/2 digit LED display driver
U516	5184887K67	analog mux/demux
U518	5184708M19	shifter hex level log level converter
U519	5184887K60	2-channel analog mux/demux
U520, U521, U522	5184887K04	quad bilateral switch
U523	5184320A47	+5 V voltage regulator
VR500	4883461E02	<u>VOLTAGE, regulator:</u> (SEE NOTE) Zener, 13 V
VR501, VR502	4882256C72	Zener, 5 V
Z500 thru Z508	5182142K15	<u>HYBRID:</u> resistor network
Z509 thru Z512	5182142K06	resistor network
Z513, Z514, Z515	5182142K15	resistor network
Z516 thru Z519	0182989R29	transmitter filter hybrid module
Z520 thru Z522	5182142K02	resistor network
		<u>MECHANICAL PARTS:</u>
	4305885J03	insert. threaded: metric; 4 used
	0382009T01	screw, machine: 2-56 x 1/2"; 4 used
	0400002625	washer, lock: #2 split
	0982808R09	socket, IC 24 contact: (U500, U501) 2 used
	6406935M04	panel, front output
	0310943J14	screw, 3.5 x 0.6 x starpan; 3 used
	0210239A03	nut, hex, 4-40 x .250 x .098 nylon; 2 used (U512, U523)
	0310129A07	screw, 4-40 x 3/8 nylon; 2 used (U512, U523)
	1483820M02	insulator, heat conductor (U512, U523)
	2682271P01	heat sink (U512, U523)
	0400009777	washer, lock; 4 used
	0984728L01	plug, shorting; 16 used

NOTE: For optimum performance, diodes, transistors, crystals, and integrated circuits must be ordered by Motorola part numbers.

PARTS LISTS

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	1583183N05	<u>CONNECTOR, plug:</u> housing, 2-contact
	3983145N01	contact, plug
	4210217A02	<u>NON-REFERENCED ITEM:</u> strap, tie .091 x 3.62"; 6 used

PARTS LISTS

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
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	3006948M03	<u>CABLE:</u> flat w/connectors
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PARTS LISTS

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	3006948M04	<u>CABLE:</u> flat w/connectors
	4206958M01	<u>MECHANICAL PART:</u> clip, routing flat cable; 3 used

PARTS LISTS

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	0284410P05	nut, stamped: 1/4-14"; 8 used
	0300135499	screw, tapping: 1/4-14 x 5/8"; 8 used
	0383498N10	screw, tapping: M3.5 x 0.6 x 8; 10 used
	0706931M02	bracket, cardcage: 2 used
	4210217A10	strap, tie; white
	4283741R01	clip, cable; snap-in, white; 3 used
	4284245N02	clip, wire tie; red; 2 used

PARTS LISTS

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	3006948M08	flat cable w/connectors (QKN4159A)
	3006948M07	flat cable w/connectors (QKN4160A)
	4206958M01	flat cable routing clip; 5 used (QKN4160A)



TONE KEYING MODULE WITH PRIORITY

INSTRUCTION SECTION

OPTION C175AG-SP

1. ATTACHMENTS

-- QRN4515A Transmitter Control Board Circuit Board Detail (component side)	7-SP5253351-1
-- QRN4515A Transmitter Control Board Circuit Board Detail (solder side)	7-SP5253351-2
-- QRN4515A Transmitter Control Board Schematic Diagram (sheet 1)	7-SP5253351-3
-- QRN4515A Transmitter Control Board Schematic Diagram (sheet 2)	7-SP5253351-4
-- QRN4515A Transmitter Control Board Parts List	7PL-SP5253351
-- QRN4516B Transmitter Audio Board Circuit Board Detail (component side)	6-SP5253351-1
-- QRN4516B Transmitter Audio Board Circuit Board Detail (solder side)	6-SP5253351-2
-- QRN4516B Transmitter Audio Board Schematic Diagram (Power Supply Circuitry)	6-SP5253351-3
-- QRN4516B Transmitter Audio Board Schematic Diagram (Input Circuitry)	6-SP5253351-4
-- QRN4516B Transmitter Audio Board Schematic Diagram (Gating and Output Circuitry)	6-SP5253351-5
-- QRN4516B Transmitter Audio Board Schematic Diagram (Tone Detect Circuitry and Microprocessor Interface)	6-SP5253351-6
-- QRN4516B Transmitter Audio Board Schematic Diagram (Logic Circuitry)	6-SP5253351-7
-- QRN4516B Transmitter Audio Board Parts List	6PL-SP5253351

2. DESCRIPTION

2.1 PHYSICAL

2.1.1 The Tone Keying module consists of two boards, the transmitter Audio board (QRN4516B) and the Transmitter Control board (QRN4515A), which plug into a standard DIGITAC comparator chassis.

2.1.2 The transmitter Audio board consists of the audio input circuitry, audio selecting circuitry, line drivers, code detectors, signal level detectors, tone detector, tone generation circuitry, and handset interface. In addition, console interface and transmitter interface circuitry are also provided. These circuits allow control flow to/from the console and to/from the transmitter.

2.1.3 The Transmitter Control board consists of a microprocessor and its supporting circuitry that includes Read Only Memory (ROM), Random Access Memory (RAM), and control circuitry. The board also contains a watchdog circuit used to monitor the performance of the microprocessor. Should the processor become "lost"

during code execution, the watchdog timer resets it to a power-up state. In addition, the board contains address, control, and data line buffering for communications with the Transmit Audio board.

2.2 FUNCTIONAL

2.2.1 The Tone Keying module performs two main tasks. First, it generates the key up tone sequences required to control a remotely located transmitter. Secondly, the tone keying module can be used to control which input (console audio, handset audio, or the output from the comparator) will have access to the transmitter when more than one input is active. The user can choose the priority scheme used to arbitrate this conflict.

2.2.2 The function of the Tone Keying module is defined by its interface to the rest of the system. This section describes the interface between the tone keying boards and the rest of the system. This includes the interface to the console, transmitter, RX module (comparator section of *DIGITAC*), handset, and front panel.

3. CONSOLE INTERFACE

3.1 GENERAL

3.1.1 The console interface provides a link between the Tone Keying module and the console. The physical connection to the console is provided by terminals on a 50-pin cable on the back of the *DIGITAC* chassis. The console interface can be configured as a 4-wire interface or a 6-wire interface. The configuration is selected with a service port command (see section 7.2 in this manual for a description of the service port).

3.1.2 In a 4-wire configuration, audio and tones arrive from the console on one pair of wires (Console Audio In) and voted audio is sent back to the console on one pair of wires (Console Audio Out).

3.1.3 In a 6-wire configuration, audio arrives from the console on one pair of wires (Console Audio In) and tones arrive from the console on another pair of wires (Console Tones In). Voted audio is sent to the console on a third pair of wires (Console Audio Out). the link between the console and tone keying module has several purposes. The primary purpose of the console interface is to allow the console to activate the transmitter. Another purpose is to route back to the console a more useful version of receive audio (providing handset audio mixing and a premessage mute when MDC signaling is used). The console interface consists of the following signal and control flows.

3.2 CONSOLE AUDIO IN

Audio, or both audio and tones, depending on the console interface configuration selected, arrive from the console at this port. this audio is sent to the transmitter as transmit audio. It can either be coded or clear. The input impedance at this port is 600 ohms. The nominal input level for test tone is 0 dBm, but a potentiometer (INPUT 1 LEVEL ADJUST) on the Transmitter Audio board accessible on the front panel can compensate for levels between +11 dBm and -26 dBm.

3.3 CONSOLE TONES IN

Tones arrive from the console at this port (in the 6-wire console interface configuration). First, the tones are detected and the tone sequence stored. Next, the tones are decoded and the desired functions performed (see section 3.11: Tone Keying Module Commands). Finally, the tone sequence is regenerated and sent to the transmitter. Any tones meant for use by the Tone Keying module are still sent to the station to provide console control of the station. Since tones are regenerated, the tone detection time is added to the throughput delay in coded mode and the access delay in clear mode. Tone detection is performed for any tone within 6 dB of the expected value. The input impedance of this port is 600 ohms and the input potentiometer (INPUT 2 LEVEL ADJUST) can compensate for input levels between +11 dBm and -26 dBm similar to the console audio port.

3.4 CONSOLE REPEATER DISABLE

This input control line is used by the console to control the tone keying repeater action. When the console pulls this line low, it is requesting that the repeater be shut down.

3.5 CONSOLE PRIORITY SELECT

This is an input line that is active low to allow the console to select console priority. When this line is pulled low, a console key up overrides any activity on the RX module.

3.6 RX PRIORITY SELECT

This input line is active low to allow the console to select RX module priority. When this line is pulled low, RX module activity overrides any activity on the console. Note that if both the console priority and the RX module priority lines are asserted, the priority reverts to “first in still here” priority. See the Tone Keying Priority Selection and Definition section (Section 10) for a full description of priority operation.

3.7 CLEAR SUMMING DISABLE

This input line is active low to allow the console to disable clear mode audio summing of RX Audio and Console Audio In. When clear mode summing is enabled, it overrides console priority and RX priority. Before clear mode summing can be used, an internal parameter must be modified. This is done with a command from the front panel service port (see Section 7.2). Unless this internal parameter is modified, the clear summing disable input is not used.

3.8 CONSOLE IN ACTIVE (PTT*)

This active low input signal is used to indicate that the console is currently sending audio to the tone keying module. this signal can be used in place of the function tone interface normally used in voting repeater applications. A key up sequence will be sent (HLGT, FT, LLGT) to the transmitter as soon as this line is held active.

3.9 CONSOLE DISABLE

This active low input signal is used to disable the console audio from reaching the transmitter. With the console disable low and the console repeater disable low, all audio, except handset audio, can be disabled from reaching the transmitter. This essentially shuts down the transmitter.

3.10 TONE KEYING MODULE COMMANDS

The tone keying module monitors the Console Audio In or Console Tones In lines (depending on the console interface configuration) and detects tone sequences. It can then control several of its features using this tone interface.

3.11 ACCEPTABLE TONE LIST

The following list shows the function tone frequencies that the tone keying module responds to. When the console sends a function tone to the tone keying module, that tone is detected and associated with one of the frequencies on this list. Any console tone falling more than 25Hz from a tone on this list is not considered a valid tone and no action is possible. When the console tone sequence is regenerated for transmission to the transmitter, only tone frequencies on this list can be sent. For example, if a frequency is received at 855Hz, it will be interpreted as 850Hz and repeated as 850Hz.

Frequency (Hz)	Frequency (Hz)
2175	1350
2050	1250
1950	1150
1850	1050
1750	950
1650	850
1550	750
1450	650

3.12 CONSOLE AUDIO OUT

This signal is sent back to the console and is simply RX module audio with handset audio gated on to it. No matter what the state is of the RX audio, activating the handset causes the audio from the RX module to be aborted and handset audio inserted. Also, when MDC signaling is used, a clear mode mute time is added to the beginning of a message before it is sent to the console (this mute time is selected with a front panel service port command; see Section 7.2). Except in these two cases, no ability to otherwise modify RX audio is provided. The output impedance of this port is 600 ohms and the output test tone level is adjustable from +11 dBm to -15 dBm, while the nominal level is 0 dBm. During a reset condition, RX audio is present at this output.

3.13 CONSOLE ACTIVE

This output signal is active low and is used to indicate that the audio connection to the console is active.

3.14 CONSOLE ACTIVE CODED

This output signal is active low and is used to indicate that the audio connection to the console is active and is operating in coded mode.

3.15 REPEATER

This output state line is used to inform the console of the repeater state. When the tone keying module pulls this line low, it indicates to the console that for some reason, the repeater is disabled. The reasons could be a disable from the console (either logic disable or tone control disable), front panel disable, failure in the tone keying module hardware, or failure in the RX module (determined by either lack of expansion bus communications or a failed state).

4. TRANSMITTER INTERFACE

4.1 GENERAL

4.1.1 The transmitter interface provides a link between the tone keying module and the transmitter. Key up tones, transmit audio and control information are sent to the transmitter via this interface. The physical connection to the transmitter is provided by terminals on a 50 pin cable on the back of the DIGITAC chassis. The transmitter interface can be configured as a 4-wire or a 6-wire interface. The configuration is selected with a service port command (see Section 7.2 for a description of the service port).

4.1.2 In a 4-wire configuration, audio and tones are sent to the transmitter on one pair of wires (Transmit Audio), and receiver audio is sent back to the comparator on one pair of wires (Line In: see Input Board section in manual 1S-SP5253351).

4.1.3 In a 6-wire configuration, audio is sent to the transmitter on one pair of wires (Transmit Audio) and tones are sent to the transmitter on another pair of wires (transmit Tones). Receiver audio is sent back to the comparator on a third pair of wires (Line In: see Input Board section in manual 1S-SP5253351).

4.1.4 The link between the console and the tone keying module has several purposes. the primary purpose of the console interface is to allow the console to activate the transmitter. Another purpose is to route back to the console a more useful version of receive audio (providing handset audio mixing and a premessage mute when MDC signaling is used). The console interface also consists of the following signal and control flows.

4.2 TRANSMIT AUDIO

This line carries the selected audio (6-wire configuration), or both audio and tones (4-wire configuration), to the transmitter. this line is a balanced audio line with an output impedance of 600 ohms. The output test tone level can be adjusted from +11 dBm to -15 dBm using a potentiometer on the transmitter audio board. The output level of control tones from this port is internally set relative to the level of test tone. These relative levels are discussed in the key up sequence (see Section 9).

4.3 TRANSMIT TONES

This line carries the key up tone sequences (HLGT, Function Tone, and LLGT) to allow the station to key up under tone control. The output impedance of this line is 600 ohms. The output test tone level can be adjusted from +11 dBm to -15 dBm using a potentiometer on the transmitter audio board. The output level of control tones from this port is internally set relative to the level of test tone. These relative levels are discussed in the key up sequence section (see Section 9).

4.4 TRANSMIT ACTIVE

This signal is active low and is used to indicate that the audio connection to the transmitter is active.

4.5 TRANSMIT ACTIVE CODED

This signal is active low and is used to indicate that the audio connection to the transmitter is active and is operating in coded mode.

4.6 TRANSMITTER FAIL SOFT

This signal is active low and comes from the station to indicate that a failsoft condition exists. In this condition, a tone sequence is sent back to the console to alert the operator of this situation. After the tone sequence, low level guard tone is sent to the console for the duration of the failsoft condition. This signal is typically used in trunked systems.

5. RX MODULE INTERFACE

5.1 GENERAL

The RX module interface is the interface between the tone keying module and RX Module. Interface between these two elements is done on the existing *DIGITAC* expansion bus. Cabling is accomplished by using the expansion cabling already provided on the back plane of the RX module. This signal path consists of the following major signal flows. A complete list of the RX/tone keying interface lines can be found in the *DIGITAC* comparator interconnect chart (2-SP5253351).

5.2 VOTED AUDIO BUS (AND AUXILIARY AUDIO BUS)

These audio signals are used to carry the voted and auxiliary audios to the output line drivers. They also carry the clear audio for the tone keying module that must be routed to the transmitter to perform the voting repeater function and the coded and clear audio that is routed back to the console. This interface is provided on an unbalanced bus driven by simple op-amps. Nominally, test tone is at 10 mV rms.

5.3 GLOBAL DATA BUS

This high-speed, multi-drop data bus is monitored by all *DIGITAC* modules (both RX and tone keying) for global system status and data messages. Control messages are sent on this channel. In coded mode, the current global majority and reference bit streams (which enable the tone keying module to construct the output coded signal) are output on this bus. The software interface is via a DUART serial I/O peripheral. Data is sent and received in the form of multi-byte messages in serial, asynchronous mode.

5.4 GLOBAL STANDBY

This input signal tells the tone keying module to operate in standby mode. In standby, the tone keying software operates normally. However, relays on the output audio lines prevent the key up sequences from reaching the transmitter, and also allow use of these lines by a second tone keying module. In addition, the console output control lines are tri-stated. The standby operation of the tone keying module is performed in tandem with the RX module.

6. HANDSET INTERFACE

6.1 GENERAL

The handset is a field maintenance tool useful for installing and maintaining the radio system. It can be used to allow the technician to communicate with both the console and the transmitter from the DIGITAC comparator site. A pushbutton on the handset initiates communications. Regardless of whether or not the handset has been activated, any audio entering the tone keying module (from either the console or the RX module), is summed and sent out the handset earpiece. When operating in the clear mode, this allows the technician to monitor console transmissions as well as incoming RX audio. In coded mode, the technician hears the un-decrypted coded audio. This enables the technician to detect at least the presence of some activity. It is intended that the audio present on the handset be as un-corrupted as possible. Two simple modes of operation controlled by a front panel switch are described below. Level control to and from the handset is not required and is internally set to the point for operation.

6.2 INTERCOM MODE

When the handset is activated in the intercom mode of operation, handset mic audio is sent to the console and the transmitter. No key up sequence of any kind is sent to the transmitter. If the station is keyed when the handset is activated, the station is shut down just as if the transmission was completed (using any appropriate EOM). Handset audio is then routed to the station. When handset activity is terminated, activity on these lines is resumed as if a new transmission had started complete with keying tones.

6.3 REMOTE MODE

Remote operation is very similar to the intercom mode except keying tones are sent to the station to allow it to key up. This allows a user to access the radio system from the comparator position. If a transmission needs to be terminated to enable handset operation, the station is shut down cleanly and then rekeyed. See the keyup sequence section of this manual for a description of this operation.

7. CONFIGURATION INTERFACE

7.1 GENERAL

There are two methods employed in the tone keying module for supplying configuration data. The first method is jumpers, and the second is a front panel service port on the transmitter control board.

7.2 CONFIGURATION JUMPERS

There are three shorting jumpers (J602, J605, and J612) on the transmitter audio board used to define which analog bus (voted audio and aux audio from the RX module, or transmit audio, transmit tones, and console out audio from the TX module), is sent to which line output. On the output board in the RX module there are an additional four shorting jumpers (J508, J512, J516, and J520) used to control which output signal goes to which output line driver. Voted audio and aux audio can be routed to line drivers 1 through 4 (located on the output board), while transmit audio, transmit tones, and console out audio can be routed to any of the six line drivers (line drivers 5 and 6 are located on the transmitter audio board).

7.3 FRONT PANEL SERVICE PORT

7.3.1 The second method for modifying configuration data is by plugging a terminal into the front of the transmitter control board. This method is similar to that used in the RX module. All parameters except those discussed in the preceding paragraph are adjusted through this serial port.

7.3.2 The service port utilizes a non-volatile memory or NOVRAM (this memory maintains its contents through power shutdowns). When the tone keying module is powered up, a copy of the NOVRAM parameters is put in RAM and a validity check is made. The parameter list in RAM is read directly by the software whenever parameter information is needed. When a command is issued from the service port, both the parameter list in RAM and in NOVRAM is modified. If the unit is powered down for any reason, the modified parameter list in NOVRAM is maintained. When the unit is powered up again, a copy of the NOVRAM parameters is put in RAM and normal operation is resumed.

7.3.3 Parameters adjustable from the terminal are: TBD. The service port can also be used for the following purposes:

- **EVENT LOGGING:** (Default) Comparator Events are output (one line per event) as a printable message to a dumb printer, tape logging device, CRT, or computer.

Given no other direction, events reported are as follows:

DIAGNOSTIC STATUS: Upon power up, or sensing of Diagnostic faults

- **DIAGNOSTIC ACCESS:** Specific information on internal operation can be requested by the remote control device. The requests override event logging operation. Information available: --- (TBD).

8. FRONT PANEL INTERFACE

8.1 GENERAL

System maintenance information is supplied to the user in two forms. First there are LEDs on the module front panel that are used to convey normal operating information, and second there is the front panel service port used to output more complex and more detailed information. Requests for maintenance operations are made in two ways, front panel switches and through a service terminal.

8.2 TRANSMITTER AUDIO BOARD FRONT PANEL LEDS

- **CONSOLE ACTIVE** Indicates that activity has been detected on the console audio input lines.
- **CONSOLE CODE DETECT** Indicates that activity has been sensed on the console audio lines and it is coded in nature.
- **CONSOLE SELECTED** Indicates that the console is currently sourcing audio to the transmitter.

- **RECEIVE SELECTED** Indicates that the RX module is currently sourcing audio to the transmitter. Note that when clear audio summing is on and the audio is in clear mode, both console audio and RX audio LEDs will be on.
- **REPEATER DISABLE** Indicates that the repeater has been disabled either from a local switch or from remote control.

8.3 TRANSMITTER CONTROL BOARD FRONT PANEL LEDS

- **TRANSMIT ACTIVE** Indicates that a keying sequence has been sent to the transmitter and the station should still be keyed.
- **TRANSMIT CODED** Indicates that the transmitter is active in coded mode.
- **TEST** Indicates the proper or improper diagnostic status.

ON: During power up reset and self-test operations, LED will stay ON if self-test operations fail catastrophically.

1 Flash (200 msec ON, 1800 msec OFF): Indicates a non-fatal error has been sensed by the diagnostics software. The tone keying module is up and running despite the error. Details of the error can be found by attaching a service CRT terminal to the Diagnostic Serial Port.

2 Flashes (200 msec ON, 200 msec OFF, 200 msec ON, 1400 msec OFF): Indicates that the diagnostics software has sensed a fatal error. The tone keying module has been disabled and is routing the audio from the console to the transmitter to allow the console operator use of the system. In addition, the RX audio is routed back to the console to allow the console operator to monitor the system. Details of the error may be found by attaching a Service CRT Terminal to the front panel service port.

Quick Flash (10 Hz rate, 50% duty cycle): Indicates that the service mode is being used and the comparator is not fully operational. This mode is automatically shut down if no service CRT Terminal activity is detected in 10 minutes.

OFF: Normal operating mode.

8.4 TRANSMITTER AUDIO BOARD FRONT PANEL SWITCHES

- **PTT/REPEATER DISABLE** This multi-use switch controls several related functions. Physically, it is a toggle switch that has three positions. the top position is momentary and is used to cause a transmitter key up similar to the action of the handset button. Handset mic audio is sent to the transmitter. In the center position

(latching) the switch is used to let the tone keying module function normally. Finally the lower position is latching and is used to disable the local voting repeater function of the tone keying module. In this condition, the repeater disable LED on the front panel is lit to indicate that the repeater is shut down and the logic signal going to the console to indicate repeater disable is asserted.

- **HANDSET MODE (INTERCOM /REMOTE)** This two position latching switch is used to control handset operation. Its operation is discussed in the handset interface section. In the upper position the handset can communicate with the station or console without keying the station. In the lower position a station PTT scheme is initiated whenever the handset activate button is depressed.

8.5 TRANSMITTER CONTROL BOARD FRONT PANEL SWITCHES

- **TEST/OPERATE** Activating this switch forces the TEST LED on, and releasing the switch causes a power-up self-test procedure for this tone keying CPU only. If all tests pass, the LED shuts off within 15 seconds of releasing the switch. See TEST LED for error conditions. This switch causes ONLY this CPU to reset. Other tone keying modules or RX Modules in the comparator continue to operate.

8.6 TRANSMITTER AUDIO BOARD FRONT PANEL POTENTIOMETERS

- **LINE 5 AND LINE 6** These controls allow the user to adjust the output level of the two line LEVEL SET drivers on this board. These potentiometers allow basic test tone level adjustment from +11 dBm to -26 dBm. These two line driver outputs can be used as outputs for the transmitter signals (tone or audio) or for the console out audio path.
- **INPUT 1 LEVEL ADJ** This control is used to compensate for console audio in level variations. In order to set this control, one must have already set the output line driver path using RX audio. Then, by placing a tone on the console audio in line, adjustment of the input audio level can be made. This potentiometer can compensate for an input test tone level from +11 dBm to -26 dBm.
- **INPUT 2 LEVEL ADJ** This control is used to compensate for console tones in level variations. In order to set this control, one must have already set the output line driver path using RX audio. Then, by placing a tone on the console tones in line, adjustment of the input tones level can be made. This potentiometer can compensate for an input test tone level from +11 dBm to -26 dBm.

8.7 TRANSMITTER AUDIO BOARD CONNECTORS

- **HANDSET JACK** This 6-pin telephone style connector allows a user to plug a handset into the tone keying module. the handset is a field maintenance tool useful for installing and maintaining the radio system.

8.8 TRANSMITTER CONTROL BOARD CONNECTORS

- **FRONT PANEL SERVICE** This connector is a standard 25 pin D connector. It is an RS-232-D serial PORT interface to a CRT terminal or computer device. Its default output is 8 bit ASCII Asynchronous, 9600 baud, 1 stop bit, no parity. The baud rate of the output is assigned with the same dip switches on the motherboard (of the comparator) used to assign the baud rate of the RX module diagnostic port. The user can select baud rates of 300, 1200, 2400 or 9600 baud. See Section 7.2 for more information.

9. KEY UP SEQUENCE

The subject of key up sequences is quite complex. This section first discusses simple operation involving only one user of the tone keying module, and then continues with more complex operations. All tones are internally generated whether they are used during handset, console, or RX module operation.

9.1 IDLE MODE OPERATION

While the tone keying module is idle, silence (no AC activity), is gated out to the transmitter. The tone detectors on the transmitter audio board are searching for high level guard tone which is the first indication that the console is active. In addition, the tone keying module is monitoring the expansion bus from the RX module so it can respond to activity from the RX module.

9.2 SIMPLE ACTIVITY

Simple activity is any activity that occurs while the RX module is in the idle state. This implies that only one audio input (RX audio, console audio, or handset mic audio), into the tone keying module is active. It is possible for activity to start out as simple and be elevated to complex by the addition of a second (or third) message. Note that if an additional message starts, but is considered to be lower priority, and therefore will not be taking over the system, the transition from simple to complex activity is still made. This allows the system to switch from the first message to the second at the end of the higher priority message. In order for the switch to be performed, a key down sequence must be sent at the end of the first message, and a key up sequence before the start of the second message. The key up and key down sequences can be customized to some extent for each user with commands from the front panel service port. The general form of the tone sequences is shown below. The defined key up and key down sequences are referred to as the standard sequences.

9.2.1 Clear Mode Key Up Sequence

- **Phase 1: Pre-Tone Mute Time**
This mute time is provided to prevent MDC600 signaling from being sent out to the transmitter.
Duration: 0 to 500 msec (50 msec nominal), field selectable by the front panel service port.
- **Phase 2: High Level Guard Tone (Optional)**
This tone is sent out to alert the transmitter to the start of a message.
Frequency: 2175 Hz
Level: 0 dB (± 1 dB) relative to test tone.
This level can be redefined to -10 dB using the service port on the front panel of the transmitter control board.
Duration: 0 to 500 msec (120 msec nominal), field selectable by front panel service port.

- **Phase 3: Function Tone One (Optional)**
 This is the first function tone used to control the station.
 Frequency: 650 Hz to 2050 Hz field selectable by front panel service port.
 Single Tone Default: TBD
 Double Tone Default: TBD
 Level: -10 dB (± 1 dB) relative to High Level Guard Tone.
 Duration: 0 to 500 msec (40 msec nominal), field selectable by front panel service port.
- **Phase 4: Function Tone Two (Optional)**
 This is the second function tone used to control the station.
 Frequency: 650 Hz to 2050 Hz field selectable by front panel service port.
 Single Tone Default: TBD
 Double Tone Default: TBD
 Level: -10 dB (± 1 dB) relative to High Level Guard Tone.
 Duration: 0 to 500 msec (40 msec nominal), field selectable by front panel service port.
- **Phase 5: Low Level Guard Tone**
 This is the low level tone sent out during a message to keep the station keyed.
 Frequency: 2175 Hz
 Level: -30 dB (± 1 dB) relative to High Level Guard.
 This level can be redefined to -20 dB using the service port on the front panel of the transmitter control board.
 Duration: Throughout the message.

9.2.2 Clear Mode Key Down Sequence

- **Phase 6: Clear Hang Time**
 This is the amount of quiet audio that is sent to the station. It is the time from when LLGT is lost at the input to the tone keying module until LLGT is shut down on the output.
 For complex activity, this phase is aborted.
 Duration: 0 to 10 sec (1 sec nominal), field selectable by the front panel service port.
- **Phase 7: Clear Trailing Mute Time**
 This is the amount of time after a clear message during which the signal to the station is muted to allow the station time to prepare for the next message by undetecting LLGT.
 Duration: 0 to 5 sec (500 msec nominal), field selectable by front panel service port.

9.2.3 Coded Mode Key Up Sequence

- **Phase 1: High Level Guard Tone (Optional)**
 This tone is sent out to alert the transmitter to the start of a message.
 Frequency: 2175 Hz
 Level: 0 dB (± 1 dB) relative to test tone.
 This level can be redefined to -10 dB using the service port on the front panel of the transmitter control board.
 Duration: 0 to 500 msec (120 msec nominal), field selectable by front panel service port.
 Duration: 0 to 500 msec (120 msec nominal), field selectable by front panel service port.

- **Phase 2: Function Tone One (Optional)**
 This is the first function tone used to control the station.
 Frequency: 650 Hz to 2050 Hz field selectable by front panel service port.
 Single Tone Default: TBD
 Double Tone Default: TBD
 Level: -10 dB (± 1 dB) relative to High Level Guard Tone.
 Duration: 0 to 500 msec (40 msec nominal), field selectable by front panel service port.
- **Phase 3: Function Tone Two (Optional)**
 This is the second function tone used to control the station.
 Frequency: 650 Hz to 2050 Hz field selectable by front panel service port.
 Single Tone Default: TBD
 Double Tone Default: TBD
 Level: -10 dB (± 1 dB) relative to High Level Guard Tone.
 Duration: 0 to 500 msec (40 msec nominal), field selectable by front panel service port.
- **Phase 4: Low Level Guard Tone**
 This is the low level tone sent out during a message to keep the station keyed.
 Frequency: 2175 Hz
 Level: -30 dB (± 1 dB) relative to High Level Guard.
 This level can be redefined to -20 dB using the service port on the front panel of the transmitter control board.
 Duration: Throughout the message.

9.2.4 Coded Mode Key Down Sequence

- **Phase 5: Coded Hang Time**
 This is the amount of EOM generated from when EOM is detected at the input to the tone keying module until LLGT is shut down at the output of the tone keying module.
 For complex activity, this phase is aborted.
 Duration: 0 to 10 sec (80 msec nominal), field selectable by the front panel service port.
- **Phase 6: Post Shut Down EOM Generation**
 This is the amount of EOM generated after the LLGT is shut down to allow a station to dekey with EOM present.
 Duration: 0 to 500 msec (100 msec nominal), field selectable by the front panel service port.
- **Phase 7: Coded Trailing Mute Time**
 This is the mute time after a coded message is complete to allow the station to prepare for the next message.
 Duration: 0 to 500 msec (80 msec nominal), field selectable by the front panel service port.

9.2.5 RX Module Simple Activity

When the expansion bus indicates that activity is present on the RX module, the audio gates on the tone keying module are switched to a configuration to allow internally generated control tones to go out to the transmitter tone port. Depending upon whether the message is coded or clear, the appropriate key up and key down sequence is sent to the transmitter.

9.2.6 Handset Simple Activity

When the button on the handset is depressed and the front panel switch is in the REMOTE position, a transmitter key up sequence is initiated. Since handset audio can only be in clear mode, the clear mode key up and key down sequences are sent to the transmitter.

9.2.7 Console Simple Activity

9.2.7.1 Console activity can be initiated in one of two ways, tone access or logic access. With tone access, the tone keying module looks for a key up tone sequence from the console. This sequence has the same general form as described earlier (HLGT, FT#1, FT#2, LLGT). The sequence is first stored in memory. It is then decoded so commands intended for the tone keying module can be acted upon. Finally, the sequence is regenerated and sent to the transmitter. After the message is sent, the appropriate key down sequence is sent.

9.2.7.2 With logic access, no tone sequence is sent from the console to the tone keying module. Rather, a hardwire PTT line is activated (Console Active In). The tone keying module sends the appropriate standard key up sequence to the transmitter. When the Console Activity line is released, the appropriate key down sequence is sent to the transmitter.

9.3 COMPLEX ACTIVITY

9.3.1 Complex activity is defined as any activity that requires the tone keying module to consider two (or more) active signals on its inputs. This is also called interrupt operation. The tone keying module handles interrupt operation in a straightforward manner. If input 1 is active and input 2 becomes active, the tone keying module goes into interrupt mode. The input 2 message can have higher or lower priority than the input 1 message. If it has lower priority, the input 1 message is completed with the appropriate key down sequence (as described for simple activity). If, after completion of the input 1 message, the input 2 message is still active, it will be handled in the same way as for simple activity.

9.3.2 If the input 2 message has higher priority than the input 1 message, then the appropriate key down sequence for the input 1 message will be sent immediately followed by the appropriate standard key up sequence for the input 2 message. After the input 2 message is complete, the appropriate key down sequence is sent. If the input 1 message is still active, it will be handled as for simple activity.

10. PRIORITY SELECTION AND DEFINITION

10.1 There are two types of priorities that need to be considered, Priority Mode and Priority Selection. The former is used to determine which input signal has the highest priority. Since more than one signal can enter the tone keying module at any given time, it is necessary to arbitrate which signal is routed to the transmitter.

10.2 There are three signals that need arbitration in the tone keying module: Handset Audio, Console Audio, and RX Audio. The handset always has top priority and overrides any activity from either the console or the RX module. This provides the serviceman with a way of overriding the system. In order to arbitrate between console audio and RX audio, there are three modes of priority that the tone keying module will support: Console Priority, RX Priority, and "First In Still Here Priority" (FISH). Console priority indicates that if a RX message is in progress when the console goes active, the RX message will be preempted and the console message will take over. RX priority, as expected, is simply the opposite. "First In Still Here" means that once a message captures the transmitter, it cannot be interrupted (except by handset mic audio), until the message is completed.

10.3 The three priority modes can be dynamically controlled as well as set at system installation. The different methods for priority selection are: hardwire selection, tone remote control, NOVRAM, and software defaults. There is a level of precedence that determines which method has precedence over which. If the top level makes no selection, the next level determines the action. The last level of decision making is the system default which is for console priority. The levels of precedence are shown below.

- Highest Priority -- Hardwired Logic
Tone Remote Control
NOVRAM
- Lowest Priority --- System Default

10.4 Determining if hardware control has made a selection is easy. There are two hardware input lines that control priority. If both lines are high (inactive state), no selection is made. If the one labeled Console Priority is pulled low, a selection has been made and that decision is console priority. This will override any selection made by tone control, NOVRAM setup or software default. For tone control, there is one tone associated with each of the four input states. NOVRAM and default programming is done in the same manner as hardwire logic except a field is defined instead of a wire. Below is a table that describes each possible input state and the resulting priority. An “s” indicates priority selection, an “n” indicates no priority selection, and an “x” indicates a “don’t care” condition.

Wired Logic		Tone Control		NOVRAM		Priority
Console	RX	Console	RX	Console	RX	
s	s	x	x	x	x	First in still here
s	n	x	x	x	x	Console
n	s	x	x	x	x	RX Module
n	n	s	s	x	x	First in still here
n	n	s	n	x	x	Console
n	n	n	s	x	x	RX Module
n	n	n	n	s	s	First in still here
n	n	n	n	s	n	Console
n	n	n	n	n	s	RX Module
n	n	n	n	n	n	Console

11. MODEL QRN4515A TRANSMITTER CONTROL BOARD

11.1 The QRN4515A transmitter Control Board plugs into a *DIGITAC* comparator chassis in the far left position. The board consists of a microprocessor and its supporting circuitry including Read Only Memory (ROM), random Access memory (RAM) and control circuitry. the control circuitry such as external communications circuitry for the expansion bus.

11.2 The board also contains a watchdog circuit used to monitor the performance of the microprocessor. Should the processor become “lost” during code execution, the watchdog timer resets it to a power-up state. In addition, the board contains address, control, and data line buffering for communications with the transmit audio board. (See the External Interface section of the Functional Description section of this manual for a description of front panel LEDs, switches and connectors.)

12. MODEL QRN4516B TRANSMITTER AUDIO BOARD

12.1 GENERAL DESCRIPTION

The QRN4516B transmitter Audio Board plugs into a *DIGITAC* comparator chassis in the position that is located second from the left. the board contains all the audio processing circuitry which consists of the audio input circuitry, audio selecting circuitry, line drivers, code detector, signal level detectors, tone detector, tone generation circuitry, and handset interface. In addition, console interface and transmitter interface circuitry are on board. These circuits allow control flow to/from the console and to/from the transmitter. (See the External Interface section of the Functional Description section of this manual for a description of front panel LEDs, switches and connectors.)

12.2 LINE INPUT CIRCUITRY

12.2.1 The control tones from the console can arrive on either the same wire pair as the console audio (Console Audio In) or on separate wire pairs (Console Audio In and Console Tones In). These signals see a 600 ohm input impedance followed by a resistor divider, transformer, and input buffer. The output of the input buffer is expected to be at a level of 100 mV rms for test tone. To accomplish this, there are two input buffer controls, Console Input Audio level Adjust and Console Input Tone Level Adjust. These are accessible from the front panel and have enough dynamic range so input test tone levels between +11 dBm and -26 dBm can be adjusted for 100 mV rms at the output of the input buffer.

12.2.2 This dynamic range contains two subranges and a jumper (J601 for console audio in and J602 for console tones in) that selects the desired range. Shorting the appropriate jumper selects range 1 which accepts input levels between +11 dBm and -15 dBm. Leaving the jumper open selects range 2 which accepts input levels between 0 dBm and -26 dBm.

12.2.3 At the output of the input buffer, the console audio and console tones are split and each sent to five different circuits. These five circuits are the Tone detector, Code Processor, handset ear Audio Summer, transmit Audio Selector, and Console Audio out Selector.

12.3 TONE DETECTOR AND SIGNAL LEVEL DETECTORS

12.3.1 The input to the tone detector (console audio or console tones) is selected via a two-to-one multiplexer. The tone detector expects to see high level guard tone at 0 dBm0 (dB relative to test tone). However, this level can be redefined to be -10 dBm via the front panel service port on the transmitter control board (refer to the tone keying module External Interface section for a description of the front panel service port). All function tones are expected to be at -10 dBm0 and low level guard tone is expected to be -30 dBm0. Again, this level can be redefined to be -20 dBm0 via the front panel service port on transmitter control board.

12.3.2 This signal is then passed on to one of the signal level detectors and the variable gain stage through, if necessary, a 2175 Hz bandpass filter. The signal level detector measures the ac level of the signal and passes the information on to the microprocessor. Based on this input level, the microprocessor adjusts the gain of the variable gain stage so as to maintain a level of 100 mv rms at its output. This output is routed to the limiter and also to the other signal level detector. This signal level detector lets the microprocessor know that the gain of the variable gain stage has been adjusted properly and the right level is at the input to the limiter.

12.3.3 The output of the limiter feeds the clock of a JK flip flop. The flip flop is wired to toggle its output at every clock pulse. Thus, the frequency at the output of the flip flop is half the tone frequency. This output is sent to the gate input of a PTM (programmable timer module). A negative transition on this gate input generates an interrupt from the PTM. The microprocessor reads a register in the PTM that has a value proportional to the period of the tone, and then converts this period to the tone frequency.

12.4 CODE DETECTOR

The input to the code detector (console audio or console tones) is selected via a two-to-one multiplexer. The code detector expects to see code at 0 dBm0. A circuit utilizing the DVP control and interface IC is used to do the actual detection.

12.5 HANDSET EAR AUDIO CIRCUIT

The handset ear audio circuit takes four signals, Console Audio, Console Tones, RX Voted Audi, and RX Aux Audio, and sends the sum of them to the handset earpiece.

12.6 TRANSMIT AUDIO AND CONSOLE AUDIO OUT SELECTORS

The transmit audio and console audio out selectors are identical. They essentially contain all the switching and summing circuitry needed to send the proper audio along with tones, if required, to the output line drivers. The first stage of the selector takes six signals [Console Audio, Console Tones, RX Voted Audio, RX Aux Audio, Handset Mic Audio, and Silence (5 V reference voltage)], and selects one. or sums any combination of them. The output is sent to a four-to-one multiplexer directly or through a 2175 Hz notch filter. The notch filter filters out low level guard tone when it is present on the audio signal. Stage 2 (4-to1 Mux) selects either the output of Stage 1, the output of Stage 1 sent through the 2175 Hz notch filter, code or silence. The selected audio is sent to Stage 3. Stage 3 either selects the output of Stage 2, tones, or sums the output of Stage 2 with the tones. The output of Stage 3 is sent on to the jumper bank where it can be routed to one or more line drivers.

12.7 LINE DRIVERS

There are two line driver circuits on the board. Each contains an input buffer, a low pass filter, a level adjust control, a line driver hybrid, a transformer, and a relay. Additionally, there are four line driver circuits on the output board identical to these which can be used by this board if more line drivers are required. The input buffer provides a high input impedance and some amplification. The low pass filter wave shapes the bits in coded mode and filters noise in clear mode. The level adjust control has enough dynamic range so test tone at the output can be varied between +11 dBm and -15 dBm. The line driver hybrid and transformer convert the unbalanced input to a balanced output, and provide the necessary line isolation. The output impedance of this circuit is 600 ohms. The relay (which is normally closed) disconnects the output during a standby condition.

12.8 TONE GENERATOR

12.8.1 The tone generation circuitry consists of a PTM timer, a 5 V to 10 V level shifter, a fixed attenuator, a variable attenuator, and a low pass filter. One of two corner frequencies can be selected for the low pass filter. The microprocessor programs the PTM timer to supply a 5 V p-p square wave at the required frequency to the input of the level shifter. This signal is then level shifted to 10 V p-p.

12.8.2 The signal then goes through the fixed attenuator. the signal level at the output of the fixed attenuator is 0 dBm0. Depending on whether the tone is high level guard tone, a function tone, or low level guard tone, the variable attenuator is set for 0 dB, 10 dB, 20 dB, or 30 dB attenuation. The tone is then sent to the low pass filter. Which corner frequency will be used for the low pass filter depends on the frequency. Tone frequencies below 1300 Hz will use the low corner frequency while tone frequencies above 1300 Hz will use the high corner frequency. The output of the filter is a sine wave at the appropriate level for the tone.

12.9 CODE GENERATOR

The code generation circuitry consists of a PTM timer, a 5 V to 10 V level shifter, a jumper selectable attenuator, and a buffer. There are four coded levels possible: 0 dBm0, -6 dBm0, -10 dBm0, and -13 dBm0.

12.10 INTERNAL CONTROL

Internal control is accomplished with two LED driver chips. Each LED driver is basically a 23 bit serial in, parallel out shift register. Each cell of the shift register drives a control point (such as the 2-to-1 mux select lines).

12.11 EXTERNAL CONTROL

External control is accomplished with LED drivers for outputs, and a parallel in, serial out shift register for inputs.

12.12 INTERNAL LOOPBACK

The tone keying boards are equipped with internal loopback circuitry for power up and run-time testing. The loopback tests are designed to be able to identify a fault down to the IC level.

12.13 LEVEL SETTING PROCEDURE

There are four potentiometers that need to be set for proper operation of the system: Input # 1 level Adjust, Input # 2 Level Adjust, Line Out 5 Level Adjust, and Line Out 6 Level Adjust. Use the following procedure to set these potentiometers.

NOTE

This procedure assumes that the following jumpers are in the following positions:

J602	position A
J605	position B
J612	position B

Step 1. Plug a service terminal into the front panel service port of the kernel board. Type P and verify that status tone is enabled on the primary audio bus. If it is not, refer to the comparator parameter editing section of this manual and enable status tone on the primary audio bus. When level setting is complete, return the status tone enable parameter back to its original state.

Step 2. Remove the service terminal from the front panel service port of the kernel board and plug it into the front panel service port of the transmitter control board and enter the service mode.

Step 3. Select command R. This command routes the status tone on the voted audio bus to the output line drivers. Set the LD # 5 and LD # 6 level adjust potentiometers for the desired output levels. The recommended level for these outputs is -13 dBm. Note that test tone level is 13 dB higher than status tone level which results in a test tone level of 0 dBm. The test tone level at the output is referred to as the test tone output reference level.

Step 4. Select command C. This command routes the Console Audio In line to the Transmit Audio Bus (which is jumpered to Line Driver 5 via J602), and it also routes the Console Tones In line to the Console Audio Out bus (which is jumpered to Line Driver 6 via jumper J605).

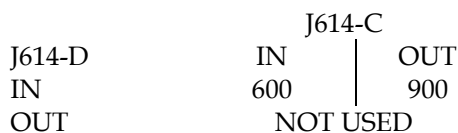
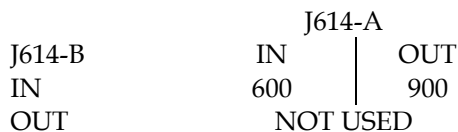
Step 5. Input test tone at the expected level into the Console Audio In port. Adjust the Input # 1 level adjust pot for the test tone output reference level at line out 5.

Step 6. Input test tone at the expected level into the Console Tones In port. Adjust the Input # 2 level adjust pot for the test tone output reference level at line out 6.

Step 7. Exit service mode.

12.14 JUMPER SETTING INFORMATION

Jumper	Position	Function
J600	IN	Console audio in port in range 1 (used for input test tone levels between +11 dBm and -15 dBm).
J600	OUT	Console audio in port in range 2 (used for input test tone levels between 0 dBm and -26 dBm).
J601	IN	Console tones in port in range 1 (used for input test tone levels between +11 dBm and -15 dBm).
J601	OUT	Console tones in port in range 2 (used for input test tone levels between 0 dBm and -26 dBm).
J602	A	Transmit audio is sent to Line Out 5
J602	B	Console audio is sent to Line Out 5
J602	C	Transmit tones are sent to Line Out 5
J605	A	Transmit audio is sent to Line Out 6
J605	B	Console audio is sent to Line Out 6
J605	C	Transmit tones are sent to Line Out 6
J608	A	Forces Line Out 5 into standby regardless of standby request line.
J608	B	Forces Line Out 6 into standby regardless of standby request line.
J608	C	Forces Line Out 5 into active (non-standby) state regardless of standby request line.
J608	D	Forces Line Out 5 into active (non-standby) state regardless of standby request line.
J612	A	Sends console audio to optional bus 2 on output board.
J612	B	Sends transmit tones to optional bus 2 on output board.



CODE LEVEL RELATIVE TO TEST TONE

	J618A	
J618-B	IN	OUT
IN	0 dB	-6 dB
OUT	-10.5 dB	-13 dB

12.15 TROUBLESHOOTING

The G command in the service mode allows a technician to generate a tone and route it to the output line drivers and also loop it back to many of the other circuits. Circuits can be checked for faults without the need for external audio oscillators.

13. PERSONALITY SETTINGS

13.1 To set up the personality for a tone keying module it is necessary to have the module operating. the module must execute all power-up diagnostics successfully. If the Test LED turns off, then the power-up diagnostics were successful. If the Test LED flashes after power-up, then something is wrong, but the power-up was probably successful. If the Test LED is on continuously, then something serious is wrong and the personality cannot be set.

13.2 It is necessary to interface a service terminal to the diagnostic serial port on the transmitter control board in order to print out and edit the personality settings. The speed of the serial port is selectable with the DIP switch on the interconnect board on the comparator chassis as described elsewhere. The port is a standard RS-232 interface that is set for 8 bits/character, 1 stop bit, and no parity.

13.3 During power-up diagnostics, a message (like the following example), should print out. Some variation in the message format is normal. Notably, the number of consecutive periods will vary depending on the vagaries of the power-up transient. If any faults are detected during power-up, they will also be printed out in this message.

```
SECURENET DIGITAC COMPARATOR
TRANSMIT SOFTWARE VERSION 1.15
COPYRIGHT MOTOROLA INC. 1988
ALL RIGHTS RESERVED
```

```
Performing self-test
```

```
.....
All chip level tests passed
Loopback testing completed
Self-test complete
```

13.4 PRINTING OUT THE CURRENT PERSONALITY

13.4.1 At this point the comparator should be operating normally and the personality will either be the last personality stored in a non-volatile memory, or a default personality that is used if the non-volatile memory was missing, faulty, or a default personality that is used if the non-volatile memory was missing, faulty, blank, or otherwise unusable. Commands to view the personality and change it are available and are entered by typing in single letters or numbers. The software contains a command interpreter that reads in the letter and immediately echoes it back to the terminal. the interpreter then responds in some way.

13.4.2 To view all of the available commands, simply type H or ? for help. The software works for upper or lower case characters equally well so it is not necessary to always use upper case. the result of the H command will be something like the following.

```
H
Useful commands:
C  Clear diagnostics          F  hardware Faults
H or ? Help                  K  coded diagnostics
L  test LED reason           P  Personality print
S  Service mode              W  Why failed
X  eXpansion status          +  power supply
G  Keyup Control Status

Other commands
D  tone Decode events        E  Expansion table
M  Module table              T  Time count
U  DUART faults              V  software Version
.  special help
```

13.4.3 The explanation for all of these commands is done elsewhere in this manual. For now, only the P and the S command are required. To view the current personality settings type the letter P. The result will be similar to the following print out depending on the software version.

P COMMAND

Personality device status = good

MEMO : John Doe's Digitac
DATE : 06/15/88
Configuration : Conventional Coded

GENERAL:

Tones at +6dB : N
Internal Repeater Disable : N
Internal Console Disable : N
Internal Auxiliary Disable : N
Tones in on Console Audio Line : N
Send Failsoft Tones to Console : N
Transmit Audio Notch Filter : N
Tones Out on Transmit Audio Line : N
Enable CIT Duplex Logic Input : N
Priority Mode (1/2/3): Cns/Rptr/Aux
Function Tone Filter Corner (Hz) : 1300
Suppress Console Tone Regeneration: N

< HIT SPACEBAR TO CONTINUE >

HIGH LEVEL GUARD TONE:

Level (dB0) : 0
Duration (msec) : 120
On for Clear Key-up : Y
On for Coded Key-up : Y
Decode Frequency Tolerance (Hz) : 10
Decode Level Tolerance (dB) : 10
Decode Integrator Up Gain (%) : 8
Decode Integrator Down Gain (%) : 16
Decode Variance Threshold : 26

LOW LEVEL GUARD TONE:

Level (dB0) : -30
LLGT Tone on : Y
Decode Frequency Tolerance (Hz) : 10
Decode Level Tolerance (dB) : 10
Decode Activity Time (msec) : 75
Decode Activity Threshold (dB) : -15
Decode Integrator Up Gain (%) : 1
Decode Integrator Down Gain (%) : 1
Decode Variance Threshold : 32

< HIT SPACEBAR TO CONTINUE >

FUNCTION TONE:

Level (dB0) : -10
Duration (msec) : 40
Clear Key-up Tones (Hz) : 1950, Off
Coded Key-up Tones (Hz) : 1950, Off
Number of FT to Decode : 1
Decode Frequency Tolerance : 30
Decode Level Tolerance (Hz) : 10
Decode Activity Time (msec) : 60
Decode Integrator Time (msec) : 10
Decode Variance Threshold : 101

CODED:

Code Detect Time (msec) : 30
Code Dropout Time (msec) : 40
Additional Delay (msec) : 0
Alignment Search Depth (msec) : 110
Repeater Buffer Size (msec) : 600
Console Buffer Size (msec) : 600
Additional Output Delay (msec) : 50
Repeater Buffer Post Overflow Depth : 450
Console Buffer Post Overflow Depth : 450

< HIT SPACEBAR TO CONTINUE >

KEYUP KEYDOWN TIMING:

Console Tone Delay (msec) : 130
Console Clear Logic Delay : 40
Console Coded Logic Delay : 0
Repeat Clear Delay (msec) : 200
Repeat Coded Delay (msec) : 0
Clear Repeat Dropout (msec) : 1000
Coded Repeat Dropout (msec) : 250
Interrupt EOM Duration (msec) : 80
Turn-off EOM Duration (msec) : 80
Clear Re-key Delay (msec) : 250
Coded Re-key Delay (msec) : 500
Auxiliary Clear Delay (msec) : 150
Auxiliary Coded Delay (msec) : 0

< HIT SPACEBAR TO CONTINUE >

CONSOLE RECEIVE AUDIO PARAMETERS:

Console Receive Mute Time : 0
Notch Console Audio : N
Transmit Tones to Console : Y
Route Transmit Audio to Console : Y
 Allow Repeater Audio : N
 Allow Console Audio : N
 Allow Handset Audio : N
 Allow Auxiliary Audio : N

< HIT SPACEBAR TO CONTINUE >

CONTROL SEQUENCES:

Repeat Enable : GT, 1450
Repeat Disable : GT, 1550
Console Enable : NOT ALLOWED
Console Disable : NOT ALLOWED
Auxiliary Enable : NOT ALLOWED
Auxiliary Disable : NOT ALLOWED
Select Auxiliary Priority : NOT ALLOWED
Select Console Priority : NOT ALLOWED
Select Repeat Priority : NOT ALLOWED
Select First In Priority : NOT ALLOWED
Priority Revert : NOT ALLOWED
Clear Summing Enable : NOT ALLOWED
Clear Summing Disable : NOT ALLOWED

FAILSOFT TONE SEQUENCE:

High Level Guard Tone : N
Function Tones : Off, Off

< HIT SPACEBAR TO CONTINUE >

VALID TONE LIST:

Guard Tone Frequency : 2175

Valid Tones: 2050 1950 1850 1750 1650 1550 1450 1350 1250 1150 1050 950 850
750 650

SERIAL I / O:

New Line ASCII Characters : <CR> <LF>

Line Length : 64

Character Delays (msec) : 4

Line Delays (msec) : 0

Print Out Complete

13.4.4 The first 2 lines are labeled MEMO and DATE. These are general purpose lines stored in the personality for use by field personnel. They have no assigned function in the software and can be set in any way that is useful. The suggested usage is to set the MEMO to some kind of information about the personality such as the person who last adjusted it. The DATE could be used to set the date when the personality was set. The default settings are blank. There are up to 31 characters allowed in the memo and up to 9 characters allowed in the DATE.

13.4.5 The first parameter is called the System Type. This is perhaps the most important parameter if the operator wishes to quickly set up a system. There are two uses for the system type variable. When the installer requests that defaults be fetched from memory, the system type parameter determines which set of defaults will be fetched. For example, if the current system type is set to a Trunked Coded System, the fetch operation will fetch default parameters used in a Trunked Coded System. The second use for this parameter is evident in normal parameter editing. As the user modifies parameters, a default is available using the 'd' command. This default is dependent on the system type.

13.4.6 Currently there are four system types supported. They are: Conventional Coded, Conventional Clear, Trunked Coded, and Trunked Clear. The installer should select the system type that most closely matches the system being installed. It is possible to quickly see what a particular system default looks like by setting the system type ('s' command), fetching the defaults into memory ('f' command), and displaying the contents ('p' command).

NOTE

As with all Novram editing, the effects of the edit session are not stored until the write command has been issued ('w' command). Therefore, one can try a lot of experimentation and simply quit without writing to avoid effecting the current setup. However care should be taken to save any changes before experimentation begins to ensure that valid changes are saved.

13.4.7 In addition to the System Type parameter, there are 10 categories of additional parameters. These are described in the following sections.

13.5 GENERAL CONTROL PARAMETERS

The general parameter list includes those parameters that do not lend themselves to any particular group. All parameters in this section can be accessed using the 'g' command.

13.5.1 Tones at +6 dB (Y/N)

In order to provide greater noise immunity when decoding tones or control tones, it is possible to boost the level of control tones by 6 dB. This has the effect of boosting the output control tone level by 6 dB. In addition, this parameter attenuates incoming tones by 6 dB to compensate for the expected higher input level. This feature compensates high level guard tone, function tones and low level guard tone equally.

13.5.2 Internal Repeater Disable (Y/N)

This variable inhibits repeater audio from passing through the transmit side of the Digitac.

13.5.3 Internal Console Disable (Y/N)

This variable inhibits console audio from passing through the transmit side of the Digitac.

13.5.4 Internal Auxiliary Disable (Y/N)

This variable inhibits auxiliary audio from passing through the transmit side of the Digitac.

13.5.5 Tones In On Console Audio Bus (Y/N)

In order to control whether the interface to the console is two or four wires, the user simply selects tones on the console audio line for two wire interfaces. If tones are not on the console audio line they are assumed to enter on the tone port and a six wire interface is assumed.

13.5.6 Send Failsoft Tones To Console (Y/N)

For clear trunking systems where the user wishes to signal failsoft back to the console, a parameter exists to send tones to the console. This parameter completely eliminates the ability of the comparator to control a station by tone control since there is only one tone generator on the comparator. However, a hard wire interface to a station is still allowed. This parameter has no use in conventional systems. In addition, since the CIU II is responsible for failsoft control, it has no real use in coded trunking systems.

13.5.7 Transmit Audio Notch Filter (Y/N)

The transmit audio notch filter is intended to be used on audio sent to the station. It is necessary to notch audio to the station while two wire interfaces are being used to the transmitter and adding low level guard tone to the audio signal is required. It doesn't matter what source is being used for station audio, if the notch is to be used it will be. The only exception is when coded audio is being selected. It would be counter-productive to notch coded signals.

A common problem that happens with this parameter is the operator selects tones on the transmit audio line (described below) for use with a two wire interface to the transmitter, but does not enable the transmit audio notch. With this setup, the station mysteriously drops out every so often during console activity. The console is sending low level guard tone and the comparator is adding it's own low level guard tone in (without notching out the consoles guard tone). As these two sinewaves add, they either double the level of guard tone or they completely cancel each other out. However, since the low level guard tone frequencies are probably slightly

different, the two frequencies will 'beat' against each other. This causes the transmitter to suddenly drop out. This problem is quite easy to spot on an oscilloscope connected to the transmit audio line.

13.5.8 Tones Out On Transmit Audio Line (Y/N)

The user can optionally select whether the transmit audio line has control tones on it. This option along with the transmitter notch filter allows the user to specify a two or four wire interface to the transmitter. It will place guard tone and function tone on the station audio line while muting voice audio and will add low level guard tone to the audio during a message.

13.5.9 Enable CIT Duplex Logic Input (Y/N)

This input is used to enable duplex through the comparator for clear only phone patch in clear trunking systems. In addition to allowing clear only phone patch, it also enables clear audio summing in the comparator. This parameter's use may vary from one system to another.

13.5.10 Priority Mode (1/2/3)

Since it is possible for more than one input signal to the comparator to become active, priority control is required. The handset and front panel have the highest priority and the user has no control over this. However, between the auxiliary and console operators and repeater operation there are six types of priority that are selectable. They are defined in the following way (i.e. Console / Repeater / Aux). This format translates to console having top priority, repeat audio having second priority, and auxiliary input (second console or phone patch) having bottom priority. The order of the priorities is always determined by the listing. The first one listed has top priority, the second one listed has middle priority, and the third one listed has bottom priority. The other priority mode is called first in priority. The first user (console, repeat, or auxiliary) that accesses the system has control until the end of their message. When first in priority is used, after the first user message has been completed, the next user is allowed to use the system. The second user has to be finished before a third can access the system.

13.5.11 Encode Filter Select Threshold

When function tones (and guard tone) are generated, a filter is used to make the tones more sinusoidal. Because of the wide frequency range inherent in function tones, the filter used to limit harmonics in the square wave has two possible corner frequencies that the software selects based on the tone frequency. This parameter sets the cutoff frequency for the filter selection. For frequencies below the cutoff point, the lower corner is used, while frequencies above this point utilize the upper corner. This feature is intended to allow some freedom in changing the filter performance for special applications.

13.5.12 Suppress Console Tone Regeneration (Y/N)

Some systems use hardware connections between the station and the comparator that means that control tones do not need to be sent to the station. However, they might still maintain a tone remote control connection with the console to allow the console to control comparator features. For these systems the user can disable tone regeneration of console tones out to the station. In addition the user may wish to shut off all tones used during repeater operation but this is up to the user. Disabling console tone regeneration will simply mean that console tones received and decoded at the comparator will not be regenerated to the station.

13.6 HIGH LEVEL GUARD TONE (HLGT) PARAMETERS

The user can control several parameters that concern high level guard tone. All parameters in this section can be accessed using the 'a' command.

13.6.1 Level (0, -10, -20, -30 dB)

This parameter sets both the encode and decode level of high level guard tone relative to test tone. Normally, high level guard tone is sent through the system at 0 dB relative to test tone. The user can optionally set this level to 0, -10, -20, or -30 dB. On the tone input port, the corresponding gain will be inserted to compensate for the expected lower levels. On the tone encode side; appropriate attenuation will be installed to get the level to comply. This parameter is useful for solving cross talk problems and phone line compatibility issues.

13.6.2 Duration (0 to 10000 msec)

This parameter can be used to adjust the duration of the high level guard tone. It is used on both the decode and encode side of the comparator. By selecting a longer high level guard tone, the immunity to falsing detect increases at the expense of system access time. At this time 60 msec seems to be the shortest recommended duration for reliable tone detection. Another parameter is provided to turn off the encoding of high level guard tone entirely. This is done in systems that are using logic coupled PTTs. Shortening the duration of high level guard tone to zero is not recommended because of the effect it has on tone decoder operation.

13.6.3 On For Clear Key-Up (Y/N)

For the purposes of keyups, there are two flags used to control whether high level guard tone is sent before messages are started. The first is used to control the presence before clear messages, while the second is used before coded messages. The most common situation is to eliminate keyup tones before coded messages. This technique is called Key On Data. The system advantage gained is that modem fast trains can easily be suppressed at the transmitter. If control tones are encoded before coded messages, there is a time period after the last function tone is received at the station until data is present at the station when a modem will be generating some random bits. If the station is on the air after the last control tone, this "garbage" goes out over the air. To suppress this "garbage", some systems have gone to Key On Data operation. The modem still sends its "garbage" to the station, but because no keyup tones were sent it does not go out over the air. Later when the good data arrives the station keys up. This technique also shortens coded access time. The only reason the user may wish to remove high level guard tone before clear messages is when logic level control of the station is performed.

13.6.4 On For Coded Key-Up (Y/N)

See "On For Clear Key-Up".

DISCLAIMER

Minor adjustments to the following high level guard tone parameters can be used under special system conditions. Radical changes may produce indeterminate decoder performance.

13.6.5 Decode Frequency Tolerance (0 to 255 Hz)

This parameter is only modifiable by requesting to modify decode parameters. This parameter sets the decode frequency tolerance for high level guard tone. Some tolerance to frequency variations is required to compensate for tolerances in the guard tone source, resolution and tolerance in the comparator, and for frequency translation on phone lines. As far as the comparator goes, both resolution and tolerances are good enough to allow operation with a frequency tolerance of about 10 Hz (2185 to 2165), but other products (and phone lines) are not quite that good.

13.6.6 Decode Level Tolerance (0 to 50 dB)

In order to further increase the reliability of the tone decoder, an added level restriction was placed on detection. The source of this parameter measurement plays a critical role in selecting its value. Using the analog to digital converter, a measurement of the incoming signal is made. This measurement has a very little resolution (default = $\pm 10\text{dB}$) so care must be exercised so that the user does not request more precision than the A/D can provide.

13.6.7 Decode Integrator Up Gain (0 to 100%)

As the high level guard tone detector operates, it maintains an integrator to determine if the tone is present. When this integrator reaches 100%, tone detection is achieved. Each good tone segment increments the level of the integrator by the integrator up gain amount. By setting the integrator up gain to a large number the user can decrease the amount of good tone required for signal detection. This parameter is tied to the duration of high level guard tone, so when the user modifies the duration, this parameter is scaled to achieve detect in the new time frame. However, by selecting to modify the extra decode parameters for high level guard tone, the user has an opportunity to further adjust this parameter.

13.6.8 Decode Integrator Down Gain (0 to 100%)

This parameter is very similar to the Up Gain parameter previously discussed. This parameter is used as the decay factor when a tone segment is received that does not resemble high level guard tone. This parameter needs to be set so that if a different tone is being received the tone decoder will not false detect, and yet normal line does not cause the integrator to be zeroed out too quickly.

13.6.9 Decode Variance Threshold (0 to 255)

The high level guard tone variance determines how much short-term frequency variance can be tolerated on the high level guard tone. Each cycle of the incoming guard tone is recorded. If the average period of the incoming cycles is close enough to the guard tone frequency, a possible detection can occur. In addition, the variance of the periods is also analyzed. A high variance in the frequency indicates that there are other frequencies present (possibly voice or noise), while a low variance indicates that the tone is virtually pure. By adjusting the variance parameter the user may select the amount of spectral purity required to allow tone detection.

13.7 LOW LEVEL GUARD TONE PARAMETERS

The user can control several parameters that concern low level guard tone. All parameters in this section can be accessed using the 'I' command.

13.7.1 Level (0, -10, -20, -30 dB)

This parameter sets both the encode and decode level of low level guard tone relative to test tone. Normally low level guard tone is sent through the system at -30 dB relative to test tone. The user can optionally set this level to 0, -10, -20, or -30 dB. On the tone input port the corresponding gain will be inserted for lower guard tone levels. On the tone encode side, appropriate attenuation will be installed to get the level to comply. This parameter is useful for solving cross talk problems and phone line compatibility issues.

13.7.2 LLGT Tone On (Y/N)

During keyups one flag is used to control whether low level guard tone is sent during a message. Some systems use logic control to the station. In these types of systems it is desirable to also place low level guard tone on the signal. Therefore, the user can easily disable this function. Note that the user may wish to shut off the notch audio flags to take advantage of the logic controlled keyups.

DISCLAIMER

Minor adjustments to the following low level guard tone parameters can optimize for special system conditions. Radical changes may produce indeterminate decoder performance.

13.7.3 Decode Frequency Tolerance (0 to 255 Hz)

This parameter is only changeable by requesting to modify decode parameters. This parameter sets the decode frequency tolerance for low level guard tone. Obviously some tolerance to frequency variations is required to compensate for tolerances in the guard tone source variations and to compensate for both resolution and tolerance problems on the comparator side. As far as the comparator goes, both resolution and tolerances are good enough to allow operation with a frequency tolerance of about 10 Hz (2185 to 2165) but other products (and phone lines) are not quite that good.

13.7.4 Decode Level Tolerance (0 to 50 dB)

In order to further increase the reliability of the tone decoder, an added level restriction was placed on detection. The source of this parameter measurement plays a crucial role in its value. Using the analog to digital converter a measurement of the incoming signal is made. This measurement has very little resolution so care must be exercised so that the user does not request more precision than the A/D can provide.

13.7.5 Decode Tone Activity Time (0 to 10000 msec)

This time parameter determines how long after low level guard tone detect has been lost before the comparator assumes that the signal has shut down. If this parameter is set too low the comparator could drop out prematurely, while setting it too large will cause the comparator to stay keyed long after the console has dekeyed.

13.7.6 Decode Activity Threshold (0 to 50 dB)

During a message from the console there are many times when the inbound audio totally swamps the low level guard tone detectors ability to detect. During these times the comparator can stay keyed on activity only. This threshold parameter can be used to set how much activity is required to keep the comparator keyed. The threshold is always relative to the measured level of high level guard tone for each message. Therefore, it is important to set the high level guard tone level properly. If this parameter is set too low, the comparator may stay keyed on input line noise, while setting it too high will make it difficult to keep the comparator keyed. Ideally, the level should be set so that it is just above the level of audio required to swamp out the low level guard tone detector. Noisy phone lines could mean that a higher threshold is required.

13.7.7 Decode Integrator Up Gain (0 to 100%)

As the low level guard tone detector operates, it maintains an integrator to determine if the tone is present. When this integrator reaches 100%, tone detection is achieved. Each good tone segment increments the level of the integrator by the integrator up gain amount. By setting the integrator up gain to a large number the user can increase the amount of good tone required to signal detection, while decreasing it's value means more good tone is required. This parameter is tied to the duration of low level guard tone, so when the user modifies the duration, this parameter is scaled to achieve detect in the new time frame. By selecting to modify the extra decode parameters for low level guard tone the user has an opportunity to further adjust this parameter.

13.7.8 Decode Integrator Down Gain (0 to 100%)

This parameter is very similar to the Up Gain parameter previously discussed and is used as the decay factor when a tone segment is received that does not resemble low level guard tone. This parameter needs to be set so that if a different tone is being received the tone decoder will not false detect, and yet noise will not cause the integrator to be zeroed out too quickly.

13.7.9 Decode Variance Threshold (0 to 255)

The low level guard tone variance determines just how much variance can be in the low level guard tone. Each cycle of the incoming guard tone is recorded. If the average period of the incoming cycles is close enough to the guard tone frequency, detection occurs. In addition, the variance of the periods is also analyzed. A high variance indicates that there are other frequencies present (possibly voice or noise), while a low variance indicates that the tone is virtually pure. By adjusting the variance parameter the user may select the amount of special purity required to allow tone detection.

13.8 FUNCTION TONE PARAMETERS

The user can control several parameters that concern function tones. All parameters in this section can be accessed using the 'n' command.

13.8.1 Level (0, -10, -20, -30 dB)

This parameter sets both the encode and decode level of function tone relative to test tone. Normally, function tones are sent through the system at -10 dB relative to test tone. The user can optionally set this level to 0, -10, -20 or -30 dB. On the tone input port, the corresponding gain will be inserted during expected periods of function tone. On the tone encode side, appropriate attenuation will be installed to get the level to comply. This parameter is useful for solving cross talk problems and phone line compatibility issues.

13.8.2 Duration (0 to 10000 msec)

This parameter can be used to adjust the duration of function tone. It is used on both the decode and encode side of the comparator. By selecting a longer function tone, the immunity to falsing detects increases at the expense of system access time. At this time, 40 msec seems to be the shortest recommended duration for reliable tone detection. Another parameter is provided to turn off the decoding of function tones entirely. Shortening the duration of function tones to zero is not recommended because of the effect it has on tone decoder operation.

13.8.3 Enter Function Tone Frequencies [Clear/Coded Keyup Tones (Tones Defined in Valid Tone List)]

The user can specify what function tones are used in front of both clear and coded transmissions. A maximum of two function tones can be programmed by the user to ensure maximum system flexibility. In addition, the user may request fewer than two function tones by following the instructions in the editor. The function tones on all keyups, except those from the console, are the same. Console keyups are either regenerated based on what is detected, or these tone sequences are used. A common problem encountered with systems (and blamed on this parameter) is getting function tones during coded messages even though the user has shut them off. The cause of this problem is not this parameter, instead, not enough "wait" is being used before keying up to determine if a message is clear or coded. Therefore, the transmit controller is keying up clear. The "fix" needs to be installed in the keyup section.

13.8.4 Number of FT to Decode (0, 1, 2)

Up to two function tones can be used to control transmitters. For most systems it is obvious how many function tones are used. However, some systems mix the number of function tones and use different numbers for different operations. When different numbers are used in a system, the number of function tones to decode should be set to the maximum function tone count. If a greater number of function tones are sent to the comparator than it "knows" about, the extra tones are considered to be audio and are ignored. If less function tones are sent than are expected, the comparator will time out in a predetermined amount of time (the parameter Function Tone Activity Time Out). This allows the comparator to work very well in systems designed for a constant function tone count and to work fairly well when the function tone count is left floating.

DISCLAIMER

Minor adjustments to the following function tone parameters can optimize for special system conditions. Radical changes may produce indeterminate decoder performance.

13.8.5 Decode Freq Tolerance (0 to 255 Hz)

This parameter is only changeable by requesting to modify decode parameters. This parameter sets the decode frequency tolerance for function tones. Some tolerance to frequency variations is required to compensate for tolerances in the function tone source variations and to compensate for both resolution and tolerance problems in the comparator. As far as the comparator goes, both resolution and tolerances are good enough to allow operation with a frequency tolerance of about 10 Hz, but other products (and phone lines) are not quite that good.

13.8.6 Decode Level Tolerance (0 to 50 dB)

In order to further increase the reliability of the tone decoder, an added level restriction was placed on detection. The source of this parameter measurement plays a crucial role in its value. Using the analog to digital converter, a measurement of the incoming signal is made. This measurement has very little resolution so care must be exercised so that the user does not request more precision than the A/D can provide.

13.8.7 Decode Tone Activity Time (0 to 10000 msec)

This parameter controls how long the comparator will wait when fewer function tones are received than are expected. In systems where a fixed function tone count is sent, this parameter is only used when noise on the tone line makes tone detection impossible. In systems where fewer than the required number of function tones are used, this parameter becomes more important. Timing for activity starts when the tone that is already being decoded has been completed. If the parameter is set too low, valid tones could be ignored. Setting this parameter to high will raise system access time during fault conditions. A number slightly larger than the expected function tone duration is suggested.

13.8.8 Decode FT Integrator Time (0 to 255 msec)

As the function tone detector operates, it maintains an integrator to determine if the tone is present. When this integrator reaches 100%, tone detection is achieved. Each good tone segment increments the level of the integrator by the integrator up gain amount. By setting the integrator up gain to a large number, the user can decrease the amount of good tone required for detection. This parameter is tied to the duration of function tone, so when the user modifies the duration, this parameter is scaled to achieve detect in the new time frame. By selecting to modify the extra decode parameters for function tone, the user has an opportunity to further adjust this parameter.

13.8.9 Decode FT variance Threshold (0 to 255)

The function tone variance determines just how much frequency variance can be in a function tone. Each cycle of the incoming function tone is recorded. If the average period of the incoming cycles is close enough to a valid function tone, detection is possible. In addition, the variance of the periods is also analyzed. A high variance indicates that there are other frequencies present (possibly voice or noise), while a low variance indicates that the tone is virtually pure. By adjusting the variance parameter the user may select the amount of spectral purity required to allow tone detection.

13.9 CODED PARAMETERS

The user can control several parameters that concern coded operation. All parameters in this section can be accessed using the 'k' command.

13.9.1 Code Detect Time (0 to 10000 msec)

The code detect time parameter defines how long before a code detect occurred that console DVP data was available (a similar parameter for repeater code detect time is available through the receive side NOVRAM editor). While the transmit controller module is idle, it is constantly clocking data through its console data buffer. After a code detect occurs the comparator looks back in the data buffers to recover any data that entered the comparator before the code detect occurred. If this parameter is set too short, data will be lost on the front of the message, while setting it too long will cause reclocked "garbage" to be included at the beginning of the message. This parameter need only change if the code detect chip on the comparator changes, or the nature of the data changes enough to significantly effect code detect times.

13.9.2 Code Dropout Time (0 to 10000 msec)

Similar to the code detect time parameter, the code undetect time dictates the amount of time before the console code detect was lost that console DVP data was actually unavailable. If this parameter is set too short, reclocked "garbage" could be appended to the end of the actual message. If this parameter is set too long, data could be truncated from the end of the message. This parameter need only change if the code detect chip on the comparator changes, or the nature of the data changes enough to significantly effect code undetect times.

13.9.3 Additional Delay (0 to 10000 msec)

The output requested delay parameter allows the user to extend the coded throughput delay beyond the minimum throughput delay. A value of zero indicates that no additional delays are requested by the user. This is by far the most user-adjustable coded parameter, and generally the only one that will be used. The default value for this parameter is zero, so any change to this parameter will increase coded throughput delay.

13.9.4 Alignment Search Depth (0 to 10000 msec)

Under normal operation, the Digitac receive module generates a global best and a global majority data stream. These two data streams do not automatically arrive time aligned at the transmit control module. Thus, the transmit control module must search for the relative time positioning of these two data streams. The process of searching for alignment can be very costly in terms of software performance. This parameter allows the search to be restricted to a range less than the entire extent of the input buffers. This parameter is NOT affected by the interchannel delay on the receive portion of the comparator. Generally, this parameter need not be changed from its default value.

13.9.5 Repeater Buffer Size (0 to 10000 msec)

The repeater input store time parameter dictates the maximum amount of coded data stored in each of the repeater input buffers. An adequate amount of data must be stored to allow for the gradual synchronization with the input clock rate coupled with the additional coded output delays. This parameter does not affect coded throughput delay, but must always be set greater than the maximum delay expected in order to prevent premature buffer overflow conditions.

13.9.6 Console Buffer Size (0 to 10000 msec)

Similar to the repeater input store time, the console input store time dictates the amount of DVP data that can be stored in the console input buffer. An adequate amount of data must be stored to allow for the gradual synchronization with the input clock rate coupled with the additional coded output delays. This parameter does not affect coded throughput delay, but must be set greater than the maximum delay expected in order to prevent premature buffer overflow conditions. When console input data is not selected for transmit control module output, any inbound data is stored to the extent of this buffer size until either the console input message has ended or the console input stream has been selected for output.

13.9.7 Additional Output Delay (0 to 10000 msec)

The output shock absorber defines the amount of data retained in the output buffer before transmission begins. This parameter sets the basis for the minimum coded throughput delay of the system. Software loading and throughput delays may dictate some fine tuning of this parameter, but in general this parameter need not be changed from its default value.

13.9.8 Repeater Buffer Post Overflow Depth

The repeater post overflow time defines the size of a repeater input buffer after the buffer has overflowed. Overflow is detected by the buffer depth reaching the repeater input store time. This value is restricted to values greater than the repeater ready threshold time. The value to which this parameter is set becomes apparent in the delay time of repeater messages that began while another coded data stream had priority.

13.9.9 Console Buffer Post Overflow Depth

Like the repeater post overflow time, the console post overflow time defines the size of a console input buffer after the buffer has overflowed. Overflow is detected by the buffer depth reaching the console input store time. This value is restricted to values greater than the console ready threshold time. The value to which this parameter is set becomes apparent in the delay time of console messages which began while another coded data stream had priority.

13.10 KEY-UP TIMING

The most system dependent parameters are the key-up parameters. In order to provide 'clean' key ups, timing must be controlled closely. There are several parameters that can be adjusted to allow the best trade off between access time and clean operation. It should be noted that the defaults have been adjusted to assume worst case timing at the expense of access time. The following sections attempt to describe how a user might 'buy' back some of these trade offs if circumstances allow. All parameters in this section can be accessed using the 'u' command.

13.10.1 Console Tone Delay

When the console attempts to access the comparator there are two techniques it can use to signal this intention, either a logic input or a tone keyup sequence. When a tone keyup sequence is used, the comparator simply repeats to the station the tone information received. The timing on this operation would seem to be fairly simple. When the comparator first detects the keyup sequence it should probably start to repeat it without delay. However, if it does so and the message turns out to be coded, the last function tone may be finished before the transmit controller has enough data accumulated to allow coded operation.

There are two reasons that code may not be ready after the last function is sent. Internally the transmit controller requires a minimum amount of data to keep the internal data buffers operating. Until this level has been satisfied, code is not ready. This required storage is not too large a problem because in a normal system using 120 msec of guard tone, it would take 60 msec to detect it and start repeating tones. This 60 msec delay is more than enough to cover the data accumulation.

The other factor that effects the console tone delay is modem fast trains. If the comparator is tied to the console (CIU included) using a modem link, after the last function tone goes through the modem, a fast train needs to be sent to compensate the phone line path. This places a burst of noise after the last function and before the code reaches the comparator. This is where console tone delay comes in handy. The console tone delay parameter defines a wait time before repeating console control tones. This ensures that data is ready for the station when the last tone is sent. By increasing this time delay it is possible to cover modem fast trains. In addition to make this parameter easier to set, if it is too long and coded data is ready before the last control tone, the transmit controller will buffer coded data until the control tones are finished. This time delay could also be used to cover signaling techniques that the user wishes to cover at the front of console messages.

13.10.2 Console Clear Logic Delay and repeat Clear Delay

These two parameters are similar and will therefore be discussed together. These delay parameters are used to delay keyup until it can be determined if they are coded or clear and to also mask signaling at the beginning of messages. In order to provide unique keyup sequences for coded and clear, a delay needs to be placed in front of all messages to allow enough time for code detect. For normal operation, 40 msec should be enough for code detects. If a code detect should appear during this time period the keyup can be treated as coded and the proper keyup sequences be used. If a code detect occurs after this period has elapsed, the keyup continues and the code detect is handled as if the code detect had occurred in the middle of the message. It should be noted that on the

surface the keyup sequences for coded and clear are the same. However, if some coded wait time is required to ensure that data is ready after the last function tone is sent then the sequences are not the same.

A second use for this parameter is to mask signaling at the beginning of messages. MDC-600 (or 1200) data packets are commonly sent from a mobile in the field. It is desirable to send this audio to the console for decode but to suppress it from getting to the transmitter. This is possible by simply setting the clear wait time for repeat to approximately the duration of the signaling technique less the keyup sequence itself. A common problem encountered is either the clear keyup sequence is used for coded messages or there is a small silent gap after the last function tone is sent before code is output. It should be noted that Console Clear Logic Delay is used only on console messages that use the logic input for activation. Console messages that are signaled using control tone sequences alone do not use Console Clear Logic Delay.

13.10.3 Console Coded Logic Delay and Repeat Coded Logic Delay

These two parameters are used after a code detect has been discovered and before any keyup sequence is started. They are useful for ensuring that coded data is available when the keyup sequence has been completed. On the repeat side, a code detect occurs quite early but a substantial amount of time must elapse (200 msec) before data is ready in the receive portion of the comparator. Repeat Coded Logic Delay can be used to ensure that data is ready after the last function tone is sent. Like Console Clear Logic Delay, the coded delay is only used before messages originating from the console by using the logic input.

13.10.4 Clear Repeat Dropout and Coded Repeat Dropout

These two parameters are used after repeater operation for supplying repeater hang time. Users familiar with repeater operation know that a repeater stays on the air for some time after the message is complete. This delay allows another user to access the system before the station has been shut down and thus lower overall access time. A delay is provided after both clear and coded messages. During this time, low level guard tone is sent to the station to keep it keyed and in the case of coded, EOM is sent to the station to keep it operating in the coded mode. If a new message is detected during the dropout time, the time is extended until the message can be repeated before the message is placed on the air, when a console message is detected the dropout is aborted and the deque operation is commenced.

13.10.5 Interrupt EOM Duration

There are six types of interrupt operations that can occur: the console can take over from the repeat path or auxiliary path, the auxiliary device can take over from the repeat path or console path, or the repeat path can take over from the console path or auxiliary path. The console takeover is more common while the others do occur in some systems. When a take over is required and the message already on the air is operating in the coded mode, a small amount of EOM is required to ensure that mobiles in the field listening to the message in the field know that a switch will be taking place. This EOM is especially necessary during XL operation to avoid a long noise burst. Fortunately, the required EOM can be kept very short.

13.10.6 Turn-Off EOM Duration

At the end of a coded message, the comparator shuts down low level guard tone. A station takes some amount of time to detect the absence of low level guard tone. If the comparator sends silence while it waits for the station to detect the keydown, it is very likely that the station will lose code detect before it loses low level guard tone. This causes the station to deque clear, which in turn causes a noise pop on the mobile. To avoid this, the comparator can supply some EOM after low level guard tone is dropped. This ensures that the station deque coded.

For stations that are coupled to the comparator using a simple two wire interface (tones and audio mixed on same lines), it does not make sense to try and supply EOM after low level guard tone is dropped because no low level guard tone is present on the line to begin with. In addition, newer stations may remove the need for this delay and therefore the user may wish to reduce this parameter to zero.

13.10.7 Clear Re-Key Delay and Coded Re-Key Delay

After a message has been completed, some amount of delay is needed to make sure that the station is ready to accept a new keyup (Micor stations need this). This parameter can be adjusted so that the user can be assured the station has dekeyed. Again, newer stations may allow this parameter to be dropped to zero.

13.10.8 Auxiliary Clear Delay

This parameter is used to delay keyup until it can be determined if it is coded or clear and to mask signaling at the beginning of messages. For normal operation 40 msec should be enough for code detects. It should be noted that this parameter is used always on auxiliary messages because they use logic input for activation.

13.10.9 Auxiliary Coded Delay

This parameter is used after a code detect has been discovered and before any keyup sequence is started. It is useful for ensuring that coded data is available when the keyup sequence has been completed. Like Auxiliary Clear Delay, the coded delay is always used before messages originating from the auxiliary device because it uses the logic input.

13.11 CONSOLE RECEIVE AUDIO PARAMETERS

These parameters control what audio is routed back as console receive audio. All parameters in this section can be accessed using the 'b' command.

13.11.1 Console Receive Audio Mute Time (0 to 10,000 msec)

Console receive audio that is routed through the comparator can be optionally muted to help cover the presence of signaling information in messages. Specifically, in systems that use MDC-600 (or 1200) signaling, the user can set this parameter so the console operator does not hear signaling arriving from the field. Users familiar with the receive portion of the comparator know that it, too, is capable of this operation. However, in systems that require decoding of these tones AND blocking in the comparator, this parameter becomes very useful. The user would set up the system so that the receive portion of the comparator does not block any portion of the receive audio. The output of the receive portion can then be routed to an MDC-600 or (1200) decoder box (a GCC-80 for example). The console (and associated CIU II) can then be set to eliminate the MDC-600 (or 1200) signaling without effecting the decoding. Note that the muting operation in the transmit controller simply runs independently of that done in the receive portion of the comparator.

13.11.2 Console Audio Notch Filter (Y/N)

This parameter allows the user to notch console receive audio. It is intended to be used in trunking systems where failsoft is signaled using low level guard tone. At this time this parameter has no use in conventional systems.

13.11.3 Transmit Tones to Console (Y/N)

This parameter allows the user to send the tones that are going out to the transmitter back to the console(s). This parameter should only be used in a multiple console configuration so the other consoles can hear what tones are being sent out to the transmitter.

13.11.4 Transmit Audio to Console (Y/N)

This parameter allows the user to send the audio that is going out to the transmitter, back to the console(s). It should only be used in a multiple console configuration. The user can choose which of the following audio signals will be sent back to the console:

- Repeater Audio
- Console Audio
- Handset Audio
- Auxiliary Audio

If the user does not want transmit audio sent back to the console, indicated by entering N above, then the audio that is routed back to the console is only the Repeater Audio and the Handset Audio.

13.12 CONTROL SEQUENCES

Control of the comparator can be simplified using tone remote control. By sending a tone sequence to the comparator, the user may enable or disable a number of features. The user may select exactly what tone sequence controls what feature. Each tone sequence must be preceded by high level guard tone and the editor for sequences assumes this. In addition, the number of tones to decode must be set properly to ensure that the decoder performs properly. There are two features that can be used to enhance the versatility of tone control. The first is, not allowed tone sequences. By selecting a zero at the editor level, a user may disallow a tone command from being accessed by a remote user. This is useful for solving "what if" problems when a feature should simply not be recognized. The second feature is wildcards. A wildcard is simply an ability to allow any frequency to activate a command. A common use for this feature is in two function tone setups. The user can make the first tone control one feature while the second tone controls another feature. For instance, the first tone could be used to enable or disable the repeater. The second could be used to enable or disable clear audio summing. In this case, the first and last function tone are not really linked so it doesn't make sense to try and program them in terms of one another. Therefore the user should use wildcards to assure correct interpretation of the tones. The next sections describe the control functions that can be performed using tone remote control. All parameters in this section can be accessed using the 'c' command.

13.12.1 Repeater Enable / Disable

Repeater disable allows the console operator to disable the repeater action of the comparator however, the comparator can still be accessed by the console operator. This command sequence will be passed to the station to disable incabinet repeat the same way all tone sequences are passed through the comparator to the station.

13.12.2 Console Enable / Disable

Console disable disallows operator from accessing the comparator except for the re-enable command. This command is intended to be used when a console is connected in parallel to two or more transmitter control units. The transmitter control units can each control a particular transmitter using a dedicated wireline hook up. By defining the console disable sequence differently, the console operator can select the unit to talk to and proceed to do just that while the other transmit control module ignores all key up sequences. During this mode the disabled transmit control unit can still operate in the repeat mode (provided the repeater is enabled).

13.12.3 Auxiliary Enable / Disable

Auxiliary disable disallows the auxiliary device from accessing the comparator. This command is intended to be used when an auxiliary device is connected to the input of the comparator on the console tone input lines.

13.12.4 Auxiliary Priority, Console Priority, Repeat Priority, First In Priority, Priority Revert

These five control sequences are used to control the priority mode by tone remote control. The first three simply raise the associated input to the top of the priority "pile". Thus it can be used to override the field programmed priority mode. This change can be done at any time and takes effect immediately. For instance, assume the service technician has programmed the NOVRAM for Repeat/Console/Auxiliary Priority. Next, assume that a lengthy repeat transmission is in progress. Normally if the console operator tries to use the station, because of the repeat priority, the console operator will be ignored. However, if the console operator either precedes his message with a console priority command or uses a special keyup sequence which has been predefined to also select console priority, the console can take over the system. The last command available simply tells the comparator to revert to the predefined priority to allow the console operator to put the priority mode back to the NOVRAM controlled value.

13.12.5 Clear Summing Enable / Disable

The final feature controllable by tone remote control is clear audio summing. If all inbound signals are clear mode, it is possible to add them together instead of switching to a complete new signal. This operation can be selected by the console operator using a simple tone command sequence and the exact sequence used is selectable by the user.

13.13 FAILSOFT TONE SEQUENCE

In clear trunking systems the comparator is relied upon to route the failsoft indication received from the station back to the console operator. In these systems a logic signal is routed to the comparator from the station. When the station loses its connection to the central controller, it asserts the failsoft line to the comparator. The comparator then needs to convey this information back to the console operator. However, the console is typically remotely located from the comparator located from the comparator so a simple wire connection is not possible. Instead, the comparator sends a control tone sequence back to the console and maintains low level guard tone until the failsoft has been fixed. The following parameters simply control what control sequence is sent back during failsoft. All parameters in this section can be accessed using the 'z' command.

13.13.1 Failsoft High Level Guard Tone

This parameter allows the user to specify whether or not high level guard tone is used during failsoft mode. The duration and level are set in the high level guard tone section.

13.13.2 Failsoft Function Tones

This parameter defines the function tones sent back during failsoft. Currently trunking systems do not use any function tones during failsoft but these parameters allow future enhancements.

13.14 VALID TONE LIST

For the purpose of both tone encode and decode, a list of valid tones is stored internally. The 'v' command allows the user to modify this list so that unusual tone frequencies can be supported. It can also be used to eliminate a particular tone that the user wishes to make "invisible" to the comparator. The first frequency in this table is used to define the guard tone and is therefore treated specially. It should be noted that the guard tone frequency can be changed at this level, but that since hardware modifications are also required, major changes may not be successful. All other frequencies are treated generically. Frequencies are accepted from 300 Hz to 6 kHz although tones can not be decoded above 2500 Hz. If the user selects a frequency below 300 Hz the tone is assumed to be invalid and is removed from the list. Frequencies above 6 kHz are ignored.

13.15 SERIAL INPUT/OUTPUT CONTROL

Configuring the serial port interface allows using a variety of terminal devices. The most important element that can be adjusted in the serial port interface is the baud rate. This parameter is adjusted using the DIP switch on the comparator motherboard. The reader is referred to the comparator operator manual for setting this parameter. The factory setting is 9600 baud, and can be changed to 300, 1200 or 2400 baud. These parameters can be accessed using the 'i' command.

SPECIAL NOTE

When the comparator first boots up, a diagnostic message is output with copyright information and such. At this time in the booting process the NOVRAM has not been activated so printing is done using predefined defaults and none of the following features are active. However, baud rate will be set correctly so the user will still get some amount of usable data.

13.15.1 New Line Character

At the end of each output line the comparator must send a new line sequence. This sequence is definable by the user. The most generic end of line sequence is a return character followed by a line feed (Hex codes 0D 0A). The return character moves the platen to the far left while the line feed character advances the paper. Some terminals will return AND advance when either character is received. This adds a blank line between each text line which will probably cause lines to roll off the top of the terminal device. By selecting either just a return or just a line feed this can be remedied. Probably the best way to set this parameter is through experimentation.

13.15.2 Line Length

Since some terminal devices have only a limited terminal width, it is possible for the comparator to roll all lines to a definable limit. Internally, the diagnostic reports have been designed to use 64 character screens. Making the line length longer than this limit will not take advantage of bigger screens. However lowering the line length will ensure that characters are not lost beyond the terminal device's capability. The drawback to this operation is that carriage returns can be placed at odd places in the printouts. This problem is unfortunately unavoidable.

13.15.3 Character / Line Delays

Even though a terminal can receive data at a very high data rate, very few can keep up with this rate for extended periods of time. Printers are notorious for this problem as are computers that are used to emulate terminals. To overcome these limitations the user can place a small time delay between characters and a different delay between line feeds (which typically takes longer). These delays should be kept to a minimum for user convenience.

13.16 PRINTING THE PERSONALITY

13.16.1 To change the personality settings, it is necessary to enter the service mode. This is easily done with the 's' command. When the 's' command is used, the response should be as shown below. The service mode does not support any of the processes that run during the normal mode of operation. As a result, the service mode should only be entered when the comparator is not actually running a radio system. The software guards against accidental service mode entry by querying with a short message. Any response other than Yes will not result in entry into the service mode.

```
S
Do you wish to enter service mode? (y/n) --> y
Now in service mode. Type H or ? for help.
```

13.16.2 Once the service mode is entered a short prompt message is printed out to indicate that the service mode is active and the Test LED will begin to flash rapidly. In the service mode there are multiple levels for the commands and the initial level is at the top. To display the top level commands simply type H or ? and the following message will appear.

```
H
Service mode commands are:
H or ? Help
C      set up audio paths from console inputs to LINE_OUT
R      set up audio paths from RX)Voted input to LINE_OUT
G      generate tone on LINE_OUT
P      personality editing
Q      quit service mode
```

13.16.3 The first three commands, c, r, and g are used for level setting and troubleshooting and are discussed elsewhere. To change the personality settings simple type 'p'. This will enter a lower level for commands specialized to personality editing. These commands may be displayed by typing H or ? command.

P

Now editing the personality.

H

Personality editing commands are:

A	edit High Level Guard tone parameters
C	edit Control Tone sequences
D	date
E	exit personality editing
F	fetch defaults
G	edit general tone parameters
H or ?	help
I	serial I/O
K	edit coded
L	edit LLGT
M	memo
N	edit Function Tone
P	print
Q	quit service mode
R	read from nonvolatile storage
S	edit the system type
T	test
U	edit keyup keydown
V	valid tone list
W	write to nonvolatile storage
X	Transmitter Interconnect
Z	failsoft parameters

13.16.4 At this point it is useful to understand the personality storage device. It is called a non-volatile RAM or NOVRAM for short. It is designed so that it can retain its memory contents even after power is shut off. It has a significant limitation in that the non-volatile storage can only be written into relatively slowly and only for a finite number of times. Fortunately the write operation can be performed many thousands of times which is more than enough if the writes are carefully controlled. Mainly because of this limitation the software does not write to the NOVRAM unless the user tells it to. The command to do this is the 'w' command.

13.16.5 To generally use and change the personality, a separate copy is stored in the regular memory. This storage is volatile so any power interruptions while the editing process is underway will destroy the memory - but not the NOVRAM data. The contents of the copy may be initialized to the defaults with the 'f' command. The copy can also be copied from the NOVRAM itself with the 'r' command. When the service mode is first entered the copy is whatever was created by the power-up diagnostics (either the defaults or the actual NOVRAM contents).

13.16.6 The current contents of the copy may be printed or displayed with the 'p' command exactly the same way that the personality was viewed after power-up above. To edit the MEMO field of the personality the 'm' command is used as follows. The memo is entered by typing a single line of characters followed by a carriage return. If a mistake is made then simply repeat the 'm' command until the memo is as desired. The DATE field of the personality is handled in the same way. Examples of these operations are shown below.

M

The current memo is:

Type in the new memo followed by <return>.

John Doe's DIGITAC

D

The current date is:

Type in the new date followed by <return>.

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13.17 EDITING PERSONALITY SETTINGS

13.17.1 To change the GENERAL personality settings simply type the 'g' command. A typical response is shown below. In general the comparator steps through each of the values in the category one by one. For each value it first prints out the default value and the current value. The user is then allowed to type 'd' for default, <return> for the same value or any value that is desired followed by <return>. Once the user types a <return> the tone keying module processes the value and either accepts, modifies, or rejects the value. In any case the software then prints out the new value (which may be the same as the old value if there is no change). If the user makes a mistake or types an unexpected or illegal character then the comparator will reject the input and make no change to the current value.

GENERAL PARAMETERS:

To accept (DEFAULT) value: type <d> or <D>.

To accept CURRENT value: type <return>

To CHANGE: type desired value then <return>.

Tones at +6dB..... (Y/N) = (N) N : N

Internal Repeater Disable...(Y/N) = (N) N : N

Internal Console Disable....(Y/N) = (N) N : N

Internal Auxiliary Disable.(Y/N) = (N) N : N

Tones in on Console Audio Line..(Y/N) = (N) N : N

Send Failsoft Tones to Console..(Y/N) = (N) N : N

Transmit Audio Notch Filter..(Y/N) = (N) N : N

Tones Out on Transmit Audio Line..(Y/N) = (N) N : N

Enable CIT Duplex Logic Input..(Y/N) = (N) N : N

Set Priority Request:

0 = No Priority

1 = RX Priority

2 = CX Priority

3 = First In Priority..... = (2) 2 : 2

Edit restricted parameters..... (y/n)? -->

Finished.

13.17.2 At this point, the user can proceed to modify parameters from other categories or he can save the changes made and exit the service mode. Modification of parameters from other categories is done in the same way as the general parameters.

13.18 WRITING TO NONVOLATILE MEMORY

To save the new information in the nonvolatile memory use the 'w' command. The response should be as shown below. The user may now type 'q' to quit the service mode and restart. An alternative is to type 'e' to exit the personality editing function and begin some other service function. When the comparator is restarted it will read the information out of the nonvolatile memory and run with the new personality settings.

W

RAM image now saved in the personality device.

Q

Quitting the service mode.

14. TONE KEYING MODULE DIAGNOSTICS

14.1 GENERAL

The diagnostic software for the tone keying module of the *DIGITAC* comparator can be divided into two parts. the first part executes only during power-up and provides a confidence test of the tone keying module hardware. the second part executes during the normal operation of the tone keying module and continuously monitors the status of several internal devices and values to see if anything detectable has failed. While the two parts are mostly independent, there are a few cases where the functions overlap and perform identically.

14.2 POWER-UP DIAGNOSTICS

14.2.1 The power-up diagnostic information provided to the user is intended to describe the progress of the power-up testing and also the nature of any fatal faults that are detected during the power-up sequence. During the power-up sequence the tone keying module will flash the Coded and Voted indicators on the transmitter control board. If these do not flash, then something catastrophic has occurred in the sequence and the tone keying module will probably be unable to even print out a message to indicate the nature of the fault.

14.2.2 One of the earliest actions of the power-up sequence is to print out the software version number and copyright notice in a format similar to the sample power-up test shown below. If these do not print out and the Coded and Voted indicators flash at least once then the serial port is not set up for the correct bit rate or some other kind of malfunction of the serial port exists.

```
SECURENET DIGITAC COMPARATOR
TRANSMIT SOFTWARE VERSION 1.15
COPYRIGHT MOTOROLA INC. 1988
ALL RIGHTS RESERVED
```

```
Performing self-test
```

```
.....
```

```
All chip level tests passed.
```

```
Loopback testing completed
```

```
Self-test complete
```

14.2.3 After the comparator prints out the 'Performing self-tests' line it begins executing several tests. the progress of those tests is indicated with the print out of the consecutive decimal points. Since some of the tests require any power-up transients to settle out the time duration of the tests will vary from comparator to comparator. If a fatal error occurs during these tests then an error message will be printed out such as "ROM version numbers do not agree!" In this case the tone keying module will terminate the power-up sequence after the error message and attempt to restart. the possible fatal errors that may be encountered during power-up are generally confined to RAM memory errors, ROM checksum and version errors, expansion DUART errors and interrupt errors.

14.2.4 There are several hardware devices that are separately tested and the results are printed out after power-up. They may also be accessed during the normal run-time. These devices are tabulated below. In addition, the tone decode circuits undergo several tests that are designed to provide calibration data for the A/D converter as well as check on the various detectors. If these tests fail, an error message prints out.

TESTED HARDWARE DEVICES AND THEIR LOCATIONS

DEVICE	LOCATION	PURPOSE
SSDA	TA-board U632	Receives data from Console
PIA 1	TC-board U47	A/D, Shift Regs and LED Drivers
PIA 2	TC-board U49	Module ID and buffered I/O
LED Driver 1	TA-board U619	Transmit Audio and Console Audio selectors control and status
LED Driver 2	TA-board U620	
Shift Register	TA-board U613	Input control
DUART 1	TC-board U52	Expansion port
DUART 2	TC-board U53	Diagnostic port
A-D Converter	TA-board U630	Input levels
PTM 1	TA-board U615	12 kHz clock, test tone
PTM 2	TA-board U622	Tone encode /decode

14.3 NORMAL RUN-TIME DIAGNOSTICS

14.3.1 After the normal run-time mode has been entered the tone keying module will attempt to function normally. If the Test indicator on the transmitter control board should start flashing in the normal mode, then some kind of service action may be appropriate. To determine the correct action there are several commands that may be used on the run-time diagnostics to ascertain the nature of the failure.

14.3.2 To view the various commands that are accessible from the diagnostic serial port type either the H or the ? command. The result will be as shown below. The commands that are valuable to determine the nature of a fault are the 'f' and 'c' commands.

H

Useful commands:

C	Clear diagnostics	F	hardware Faults
H or ?	Help	K	coded diagnostics
L	test LED reason	P	Personality print
S	Service mode	W	Why failed
X	eXpansion status	+	power supply
G	Keyup Control Status		

Other commands

D	tone Decode events	E	Expansion table
M	Module table	T	Time count
U	DUART faults	V	software Version
.	special help		

14.3.3 The 'f' command will print out the fault indications for the hardware devices listed above. The 'f' command will display a message similar to the one at the top of the next page. each hardware device has a single bit which is cleared to a 0 if no fault is detected and is set to a 1 if a fault has been found. the sample message at the top of the next page does not show any detected hardware faults. With many of the devices the nature of a fault may be something else besides a simple failure of the IC itself. For example, the SSDA will show faults if the receive clock is absent. This signal comes from the DVP control and interface IC and it drives the SSDA IC on the transmitter audio board. As a result, something as simple as a broken track on the motherboard could show up as a fault indicated on an SSDA. The 'f' command merely gives an indicator to tell service personnel where to look next for a problem rather than specifying exactly which IC is bad.

F

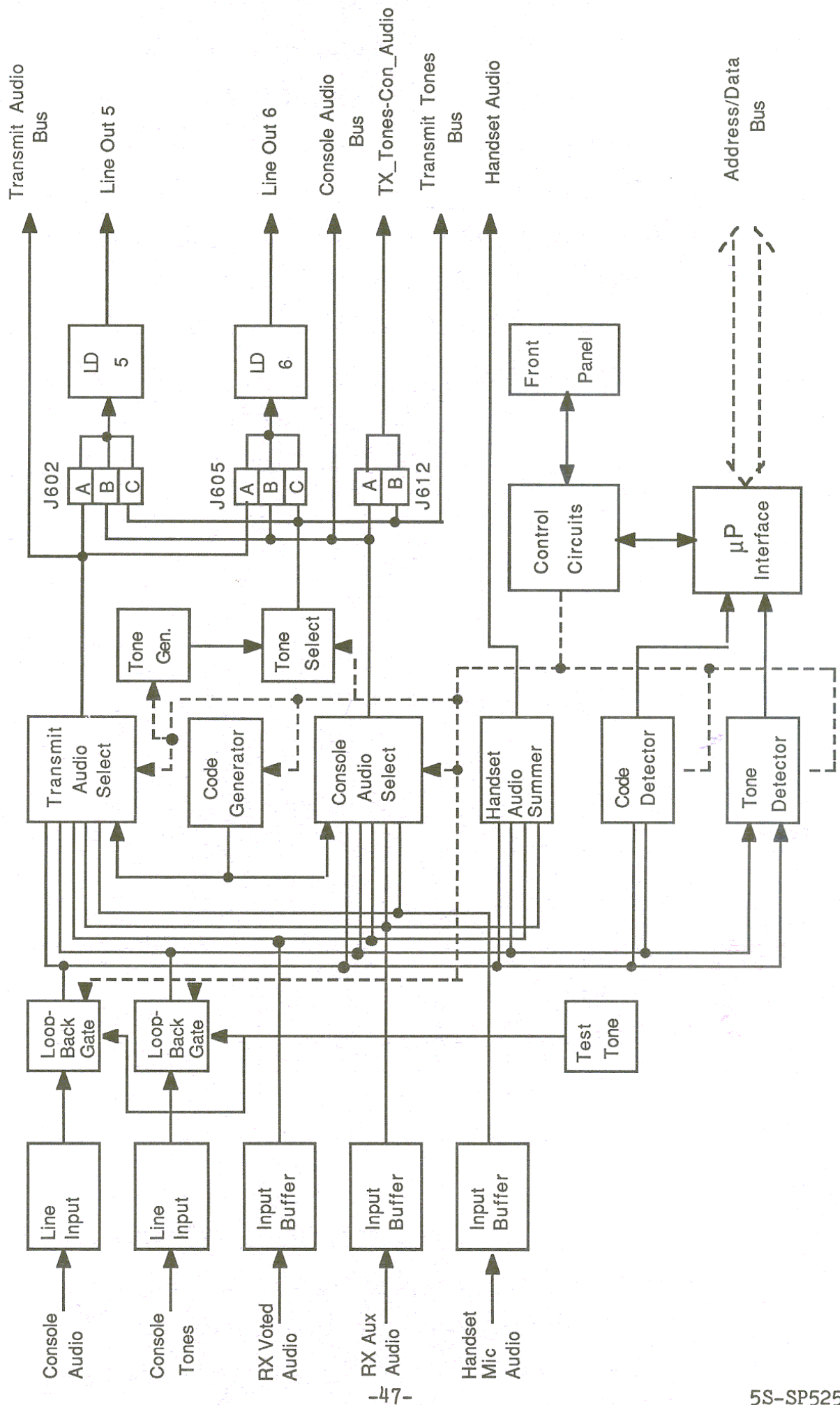
U47	PIA1	0	U49	PIA2	0
U52	DUART1	0	U53	DUART2	0
U612	VANILLA	0	U613	SH REG	0
U615	PTM1	0	U622	PTM2	0
U619	LED DR2	0	U620	LED DR1	0
U630	A/D	0	U632	SSDA	0

14.3.4 the 'c' command gives the status of the tone level calibration tests. Two level measurement circuits measure the tone level at the input to the tone detector and the input to the limiter. During power up test, the output levels of these circuits are measured with no input signal and with the test tone at the input. These values are used to determine what the noise level and the gain of the circuit is. In this way, gain and noise variations from board to board can be compensated for. Normally, the TONE INPUT SILENCE REFERENCE LEVEL and the LIMITER INPUT SILENCE REFERENCE LEVEL should be close to ff00. This indicates that no signal is present. Any noise in the circuit will push this level below ff00. this is expected as long as the level does not fall below D900. The TONE INPUT TEST TONE REFERENCE LEVEL and LIMITER INPUT TEST TONE REFERENCE LEVEL should nominally be A100. Again, a certain amount of variation is expected. this level is considered acceptable as long as it is between 2500 and 8700. the actual levels can be checked against these ranges to determine if the tone decode circuits are OK.

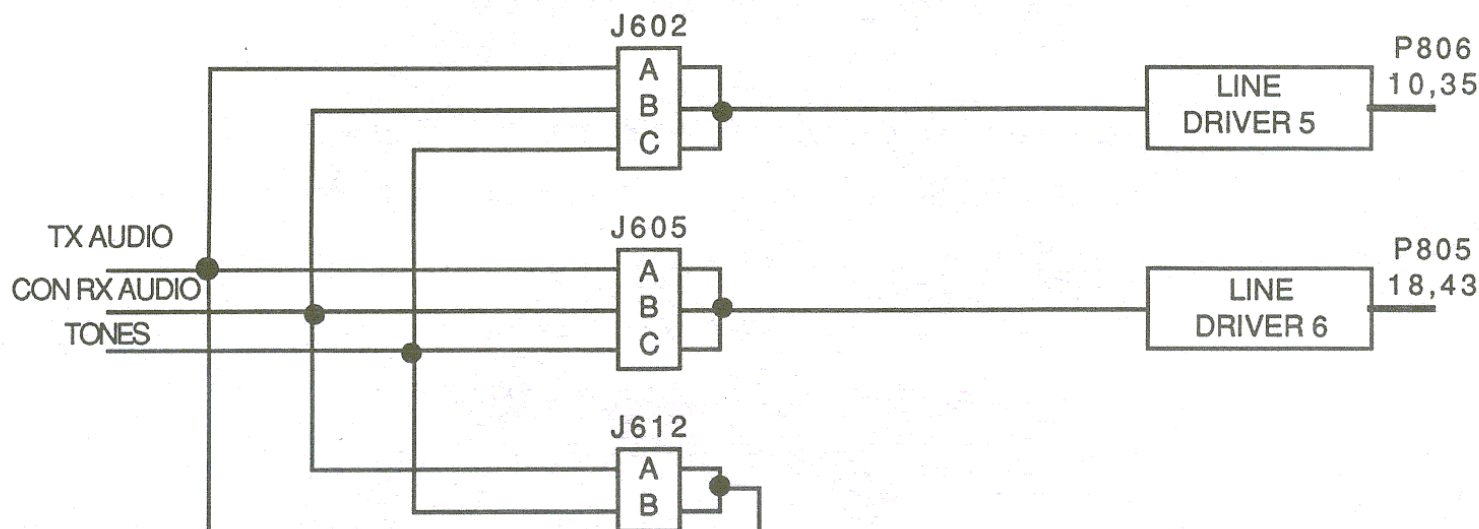
C

TONE INPUT LEVEL = -4dB
LIMITER INPUT LEVEL = -45dB
TONE INPUT TEST TONE REFERENCE LEVEL = AF00
TONE INPUT SILENCE REFERENCE LEVEL = FF00
LIMITER INPUT TEST TONE LEVEL = B100
LIMITER INPUT SILENCE REFERENCE LEVEL = FF00

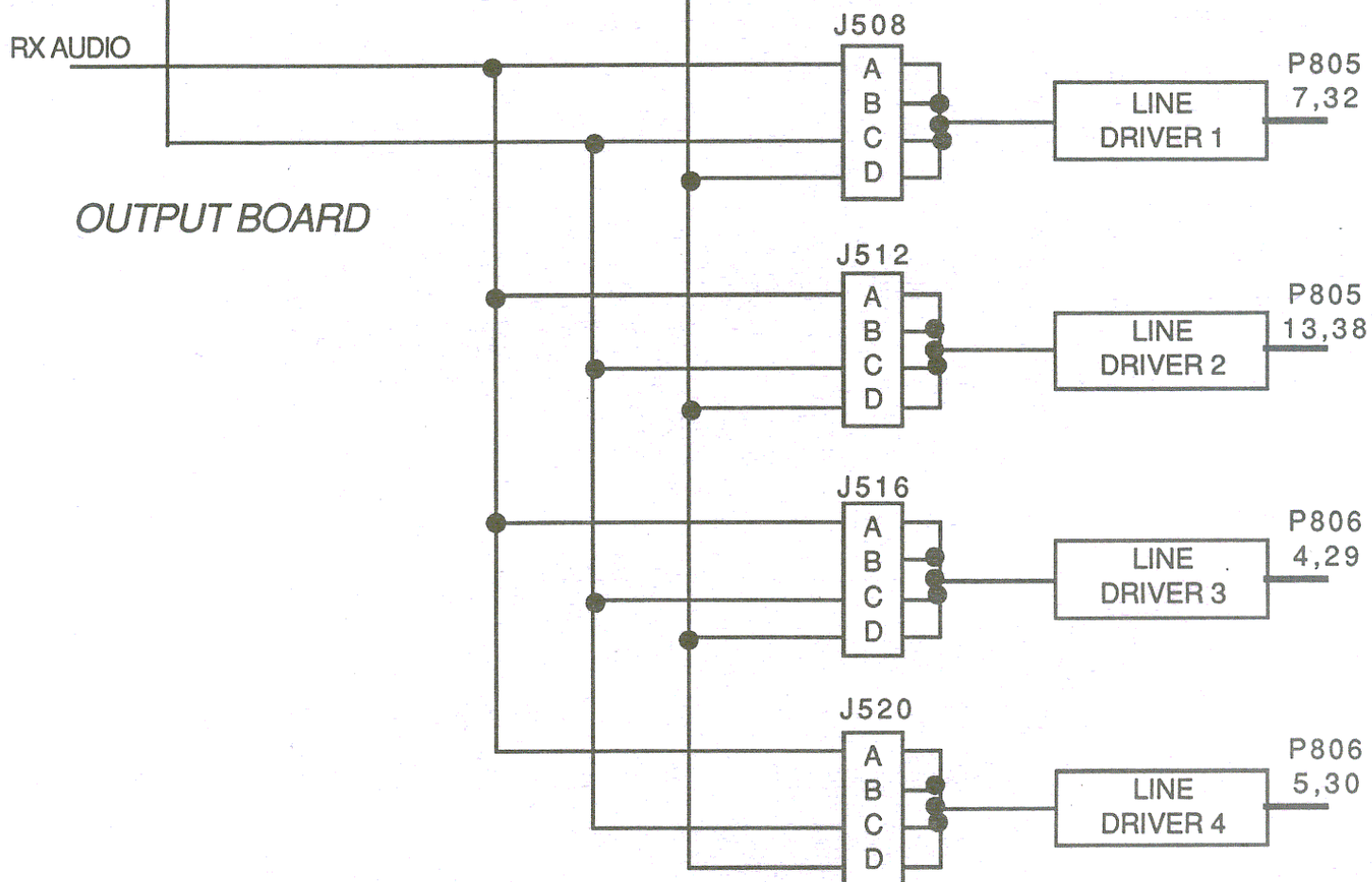
Transmit Audio Block Diagram

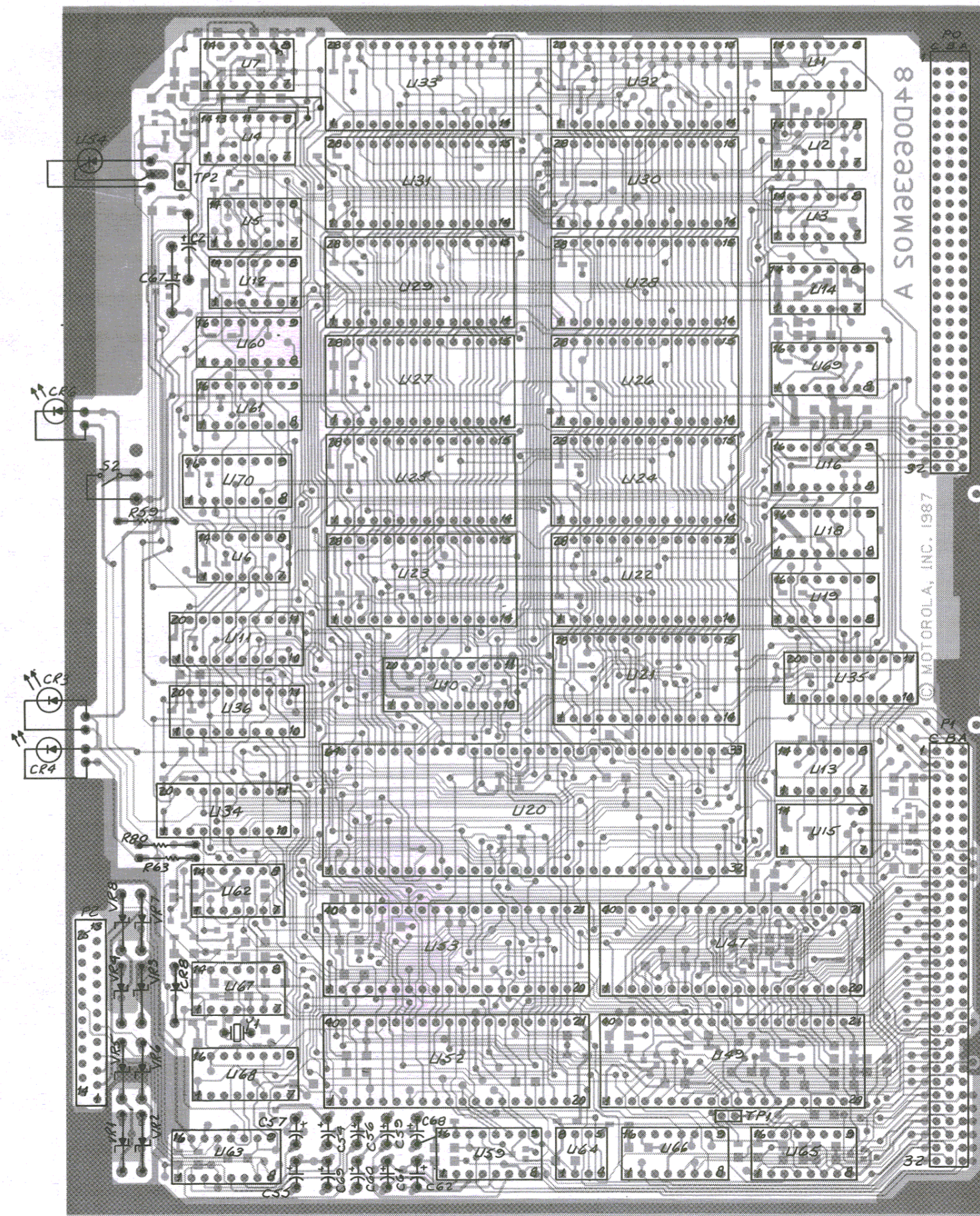


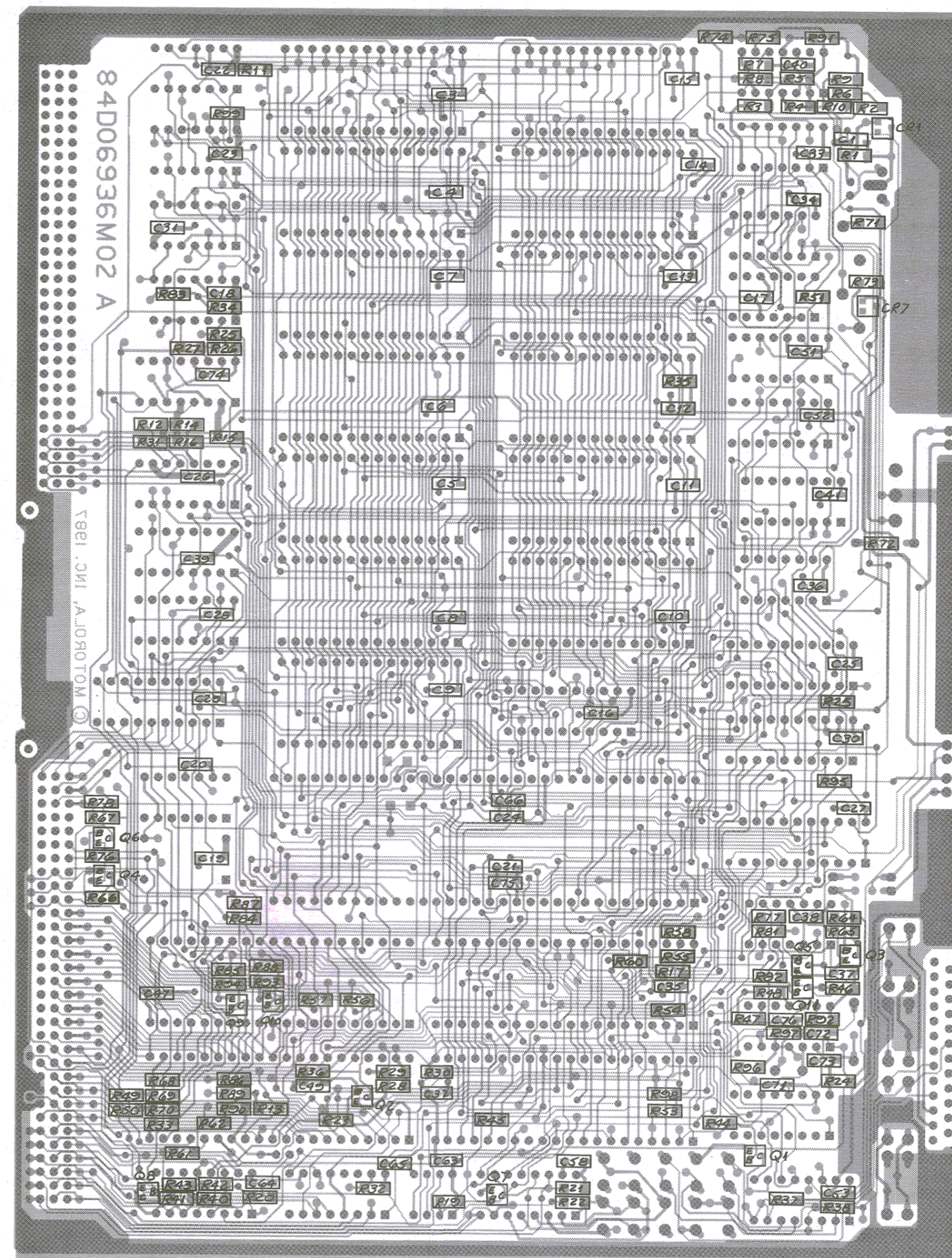
AUDIO BOARD



OUTPUT BOARD







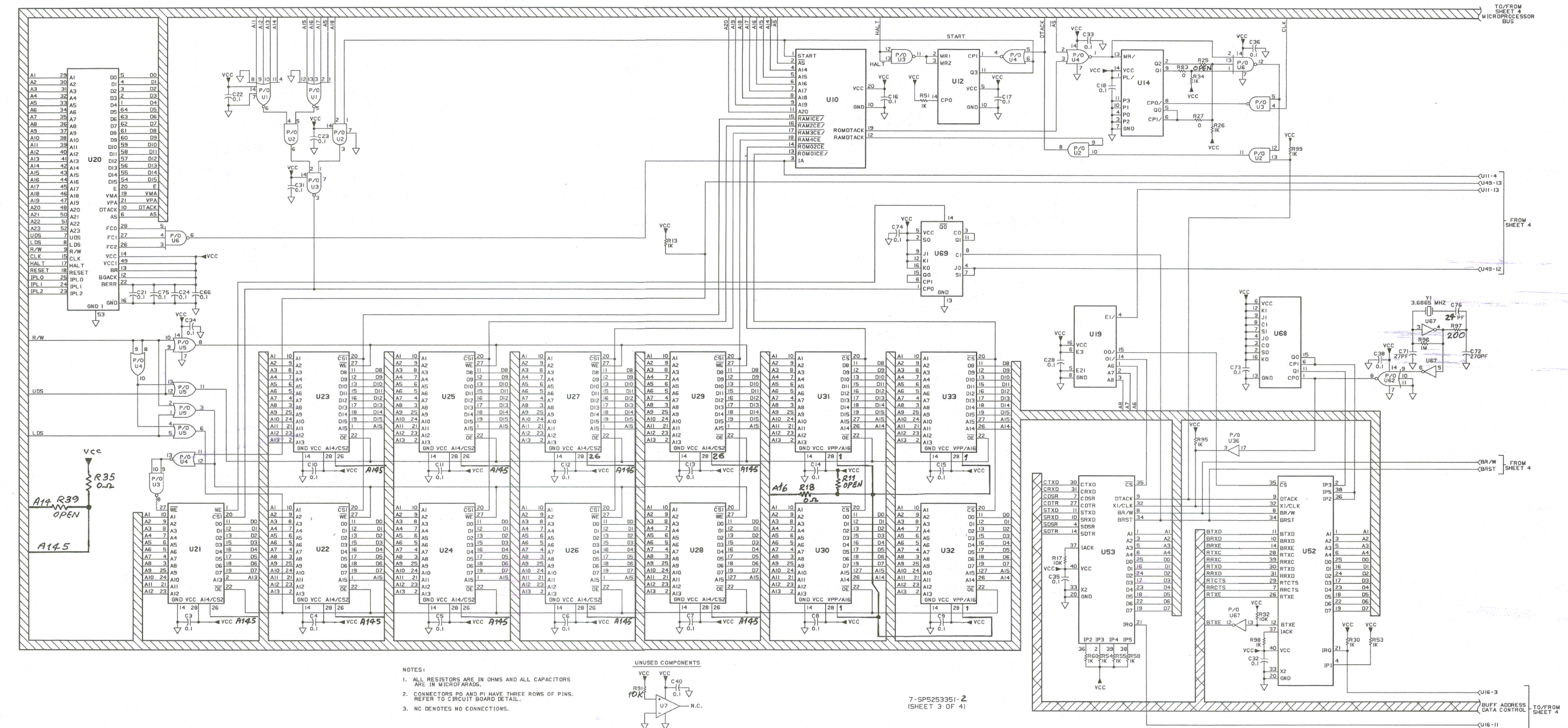
SHOWN FROM SOLDER SIDE

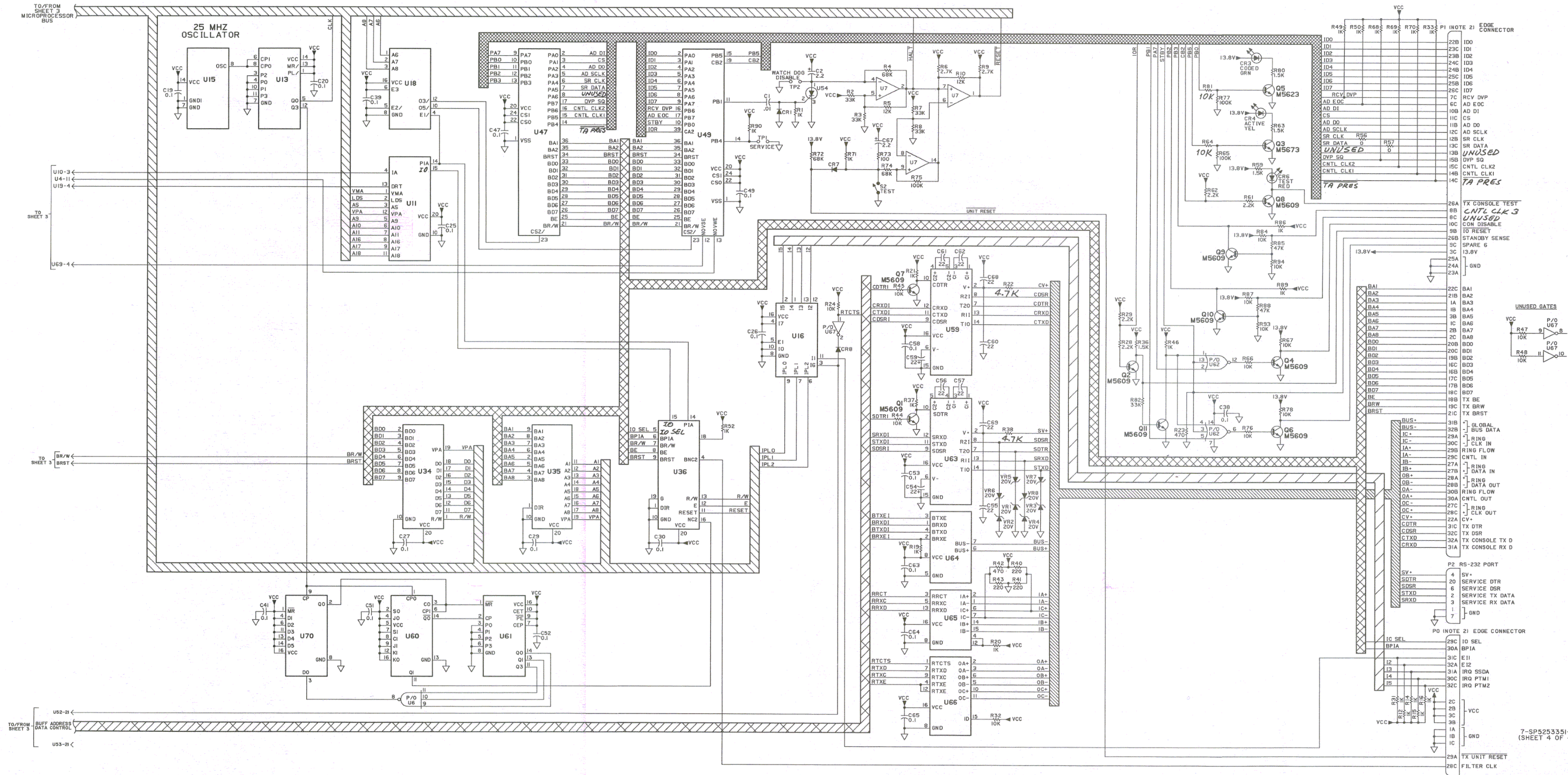
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(SHEET 2 OF 4)

QRN4515A Transmitter Control Board
Schematic Diagrams and Circuit Board Details
Motorola No. 7-SP5253351-2

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PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		<u>CAPACITOR, fixed:</u> chip, uF; $\pm 5\%$; 50 V
C1	2111032A21	0.01 $\pm 10\%$
C2	2384762H04	2.2 $\pm 20\%$ 25 V
C3 thru C41	2111032A33	0.10 $\pm 10\%$
C47	2111032A33	0.10 $\pm 10\%$
C49	2111032A33	0.10 $\pm 10\%$
C51 thru C53	2111032A33	0.10 $\pm 10\%$
C54 thru C57	2311019A27	22 $\pm 20\%$ 25 V
C58	2111032A33	0.10 $\pm 10\%$
C59 thru C62	2311019A27	22 $\pm 20\%$ 25 V
C63 thru C66	2111032A33	0.10 $\pm 10\%$
C67	2384762H04	2.2 $\pm 20\%$ 25 V
C68, C69	2311019A27	22 $\pm 20\%$ 25 V
C71	2111031A25	27pf $\pm 5\%$
C72	2111031A49	270pf $\pm 5\%$
C73 thru C75	2111032A33	0.10 $\pm 10\%$
C76	2111031A24	24pf $\pm 5\%$ 50 V
		<u>DIODE:</u> (SEE NOTE)
CR1, CR7	4811058C11	silicon
CR8	4884616A01	hot carrier
		<u>LIGHT EMMITTING DIODE:</u>
CR3	4888245C22	grn
CR4	4888245C23	yel
CR6	4888245C24	red
		<u>CONNECTOR, receptacle:</u>
P0, P1	0982236R01	receptacle 3 x32 contact 90 deg
P2	0906320B35	receptacle 25 contact
		<u>TRANSISTOR:</u> (SEE NOTE)
Q1, Q2	4811056C09	NPN, type M5609
Q3 thru Q6	4811056C23	NPN, type M5623
Q7 thru Q11	4811056C09	NPN, type M5609
		<u>RESISTOR, fixed:</u> chip, $\pm 5\%$; 1/8 W
R1	0611077A74	1000
R2, R3	0611077B11	33k
R4	0611077B19	68k
R5	0611077B01	12k
R6	0611077A84	2700
R7, R8	0611077B11	33k
R9	0611077A84	2700
R10	0611077B01	12k
R12 thru R17	0611077A74	1k

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R18	0611077A01	jumper, 0 ohms
R19, R20, R21	0611077A74	1k
R22	0611077A90	4.7k
R23	0611077A66	470
R24	0611077A98	10k
R26	0611077A74	1k
R27	0611077A01	jumper, 0 ohms
R28, R29	0611077A82	2200
R30, R31	0611077A74	1k
R32	0611077A98	10k
R33, R34	0611077A74	1k
R35	0611077A01	jumper, 0 ohms
R36	0611077A78	1500
R37	0611077A74	1k
R38	0611077A90	4.7k
R40, R41, R43	0611077A58	220
R42	0611077A66	470
R44, R45	0611077A98	10k
R46	0611077A74	1k
R47, R48	0611077A98	10k
R49 thru R55	0611077A74	1k
R56, R57	0611077A01	jumper, 0 ohms
R58	0611077A74	1k
R59	0611009A53	1500, ¼ W
R60	0611077A74	1k
R61, R62	0611077A82	2200
R63	0611009A53	1500, ¼ W
R64	0611077A98	10k
R65	0611077B23	100k
R66, R67	0611077A98	10k
R68 thru R71	0611077A74	1k
R72	0611077B19	68k
R73	0611077A50	100
R74	0611077B19	68k
R75	0611077B23	100k
R76	0611077A98	10k
R77	0611077B23	100k
R78	0611077A98	10k
R80	0611009A53	1500, ¼ W
R81	0611077A98	10k
R82	0611077B11	33k
R83	0611077A01	jumper, 0 ohms
R84	0611077A98	10k
R85	0611077B15	47k
R86	0611077A74	1k
R87	0611077A98	10k
R88	0611077B15	47k
R89, R90	0611077A74	1k

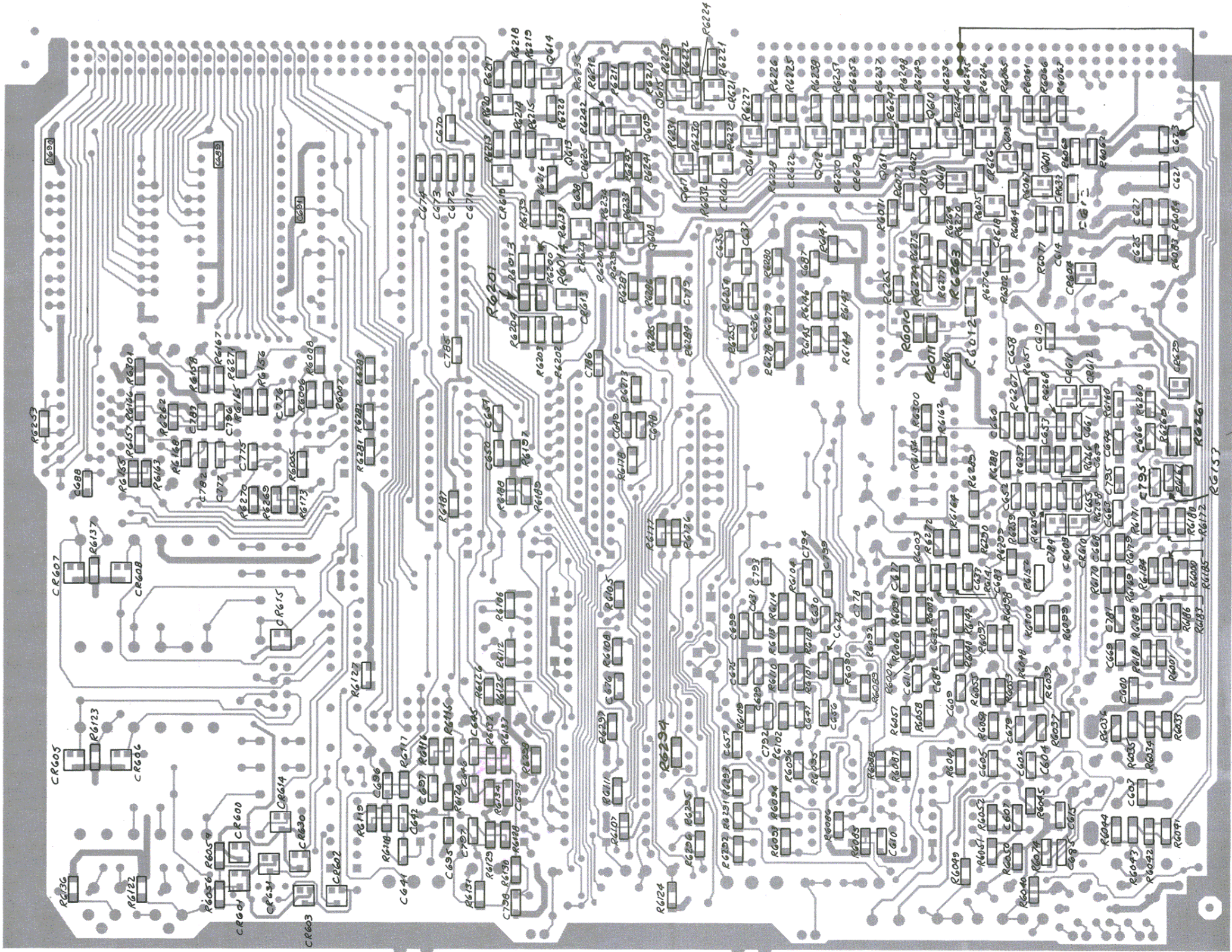
PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R91 thru R94	0611077A98	10k
R95	0611077A74	1k
R96	0611077B47	1 meg
R97	0611077A57	200
R98, R99	0611077A74	1k
S2	4083249K13	<u>SWITCH:</u> spst
TP1, TP2	2884318M06	<u>TEST POINT:</u> plug 2 pin
U1	5184118K84	<u>INTEGRATED CIRCUIT:</u> (SEE NOTE) dual 5-input NOR gate
U2	5183548N02	gates pos w/totem pole output
U3	5184118K06	quad NAND gate 2 input
U4	5184118K13	quad NOR gate 2 input
U5	5183627M31	gates pos or w/totem pole out
U6	5184118K29	NAND gate triple 3 input
U7	5184320A51	quad comparator
U10	5106370M46	programmable array logic
U11	5106320M37	programmable array logic
U12	5184118K04	counter binary 4 bit
U13	5184810F32	counter decade presettable
U14	5184118K52	counter programmable 4-bit binary
U15	4806413K03	crystal clock oscillator
U16	5184118K58	priority encoder 8 to 3 line
U18, U19	5184118K34	decoder 3-line to 8-line
U20	5106472A92	microprocessor
U21	5106954M01	static RAM
U22 thru U29	5106636L05	static RAM
U30	5106370M67	64k x 8 EPROM
U31	5106370M68	64k x 8 EPROM
U32	5106370M69	64k x 8 EPROM
U33	5106370M70	64k x 8 EPROM
U34 thru U36	5184118K80	octal transceivers bus
U47	5184944N46	PIA
U49	5184944N46	PIA
U52, U53	5106471A44	DUART
U54	4800869577	transistor type M9577
U59	5106953M01	transmitter/receiver RS232
U60	5184118K59	dual j-k flip-flop w/preset and clear
U61	5184118K44	4 bit binary sync counter
U62	5184118K18	NOR gate triple 3-input
U63	5106953M01	transmitter/receiver RS232
U64	5106490A20	driver
U65	5184621K45	quad RS-422/423 line receiver
U66	5184621K46	quad line driver

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
U67	5183810P38	inverter
U68, U69	5184118K59	flip-flop dual j-k w/preset and clear
U70	5184118K46	flip-flop hex D type
VR1 thru VR8	4882256C39	<u>VOLTAGE</u> , regulator: (SEE NOTE) Zener, 20 V
Y1	4882611M20	<u>CRYSTAL</u> : oscillator
		<u>NON-REFERENCED PARTS:</u>
	0982808R06	SOCKET, 20 contact; 2 used
	0982808R10	SOCKET, 28 contact; 13 used
	0982808R11	SOCKET, 40 contact; 2 used
	0982808R13	SOCKET, 64 contact; 1 used
	0984728L01	SOCKET, connector; 2 used
	4305885J03	NUT, 2-56 x 3/16 x 1/16"; 4 used
	0200120945	NUT, 4-40 x 3/16 x 1/16"; 2 used
	0382009T01	SCREW, 4 used
	0300400100	SCREW, machine 4-40 x 3/8"; 2 used
	0310943J14	SCREW, tapping TT3.5 x 0.6 x 6mm; 3 used
	0400009777	WASHER, lock #4 split; 2 used
	6406935M08	PANEL, front; TX control; 1 used
	7505295B01	PAD, crystal base

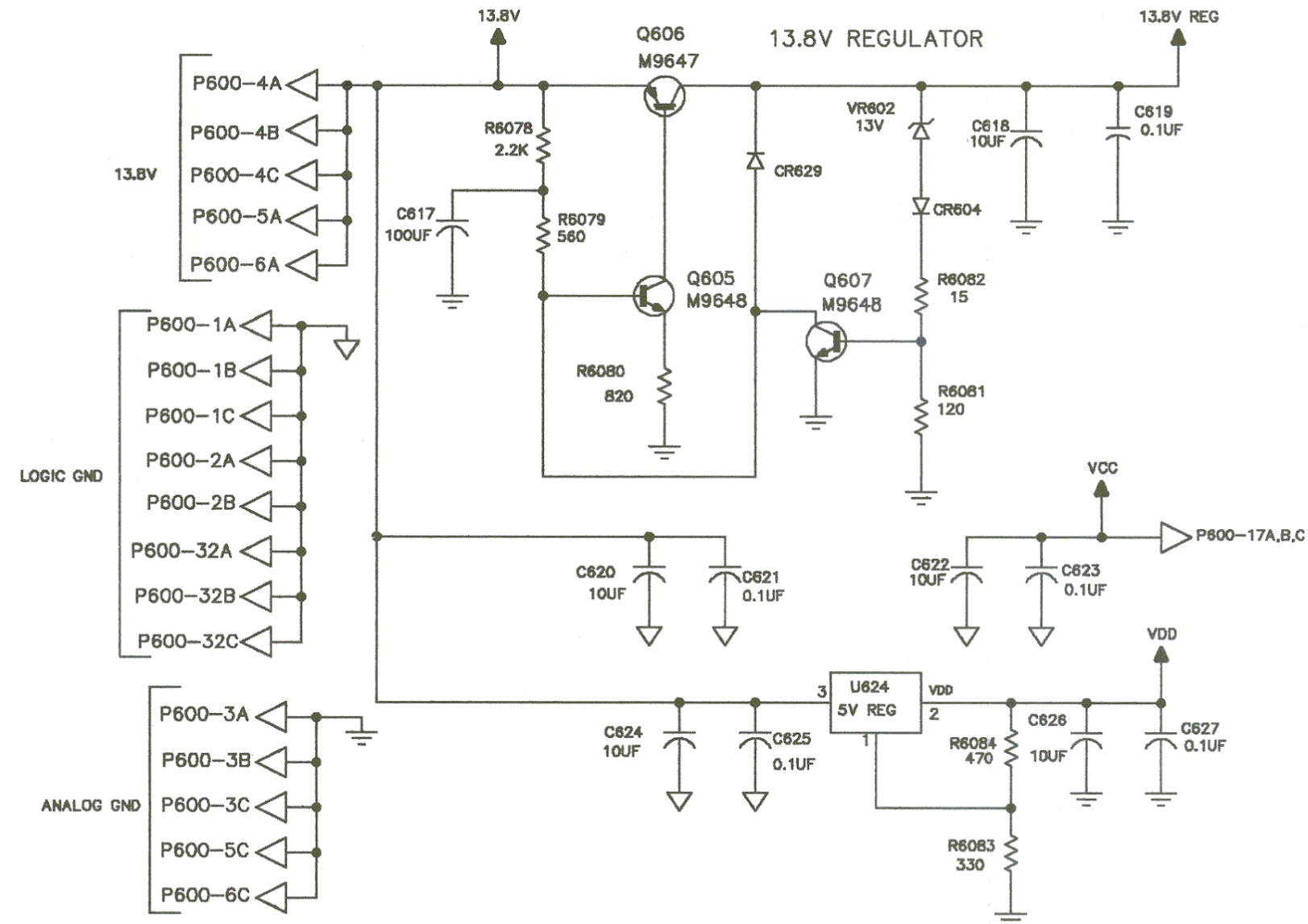
NOTE: For optimum performance, diodes, transistors, crystals, and integrated circuits must be ordered by Motorola part numbers.



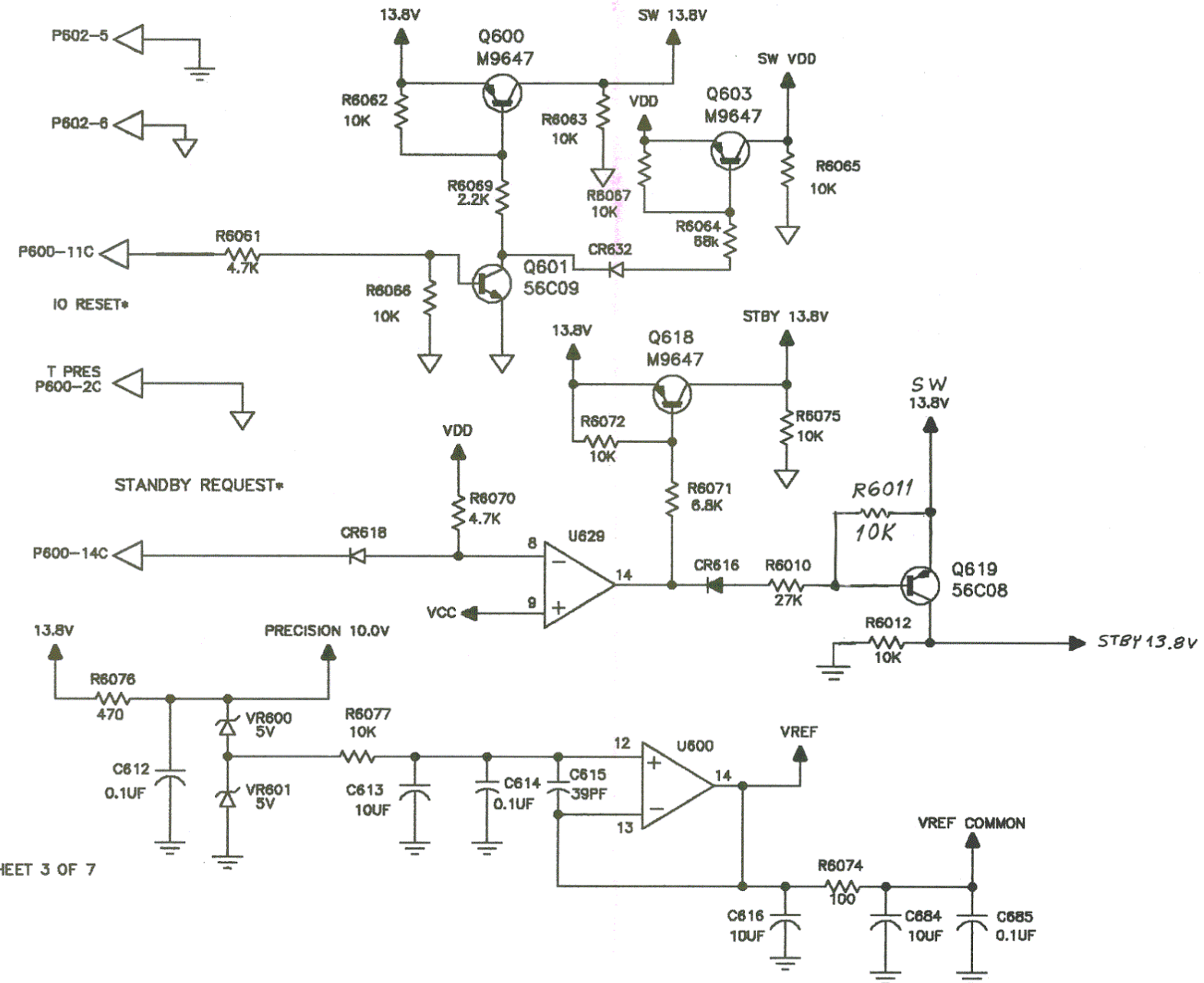
SHOWN FROM SOLDER SIDE

6-SP5253351-4
(SHEET 2 OF 7)

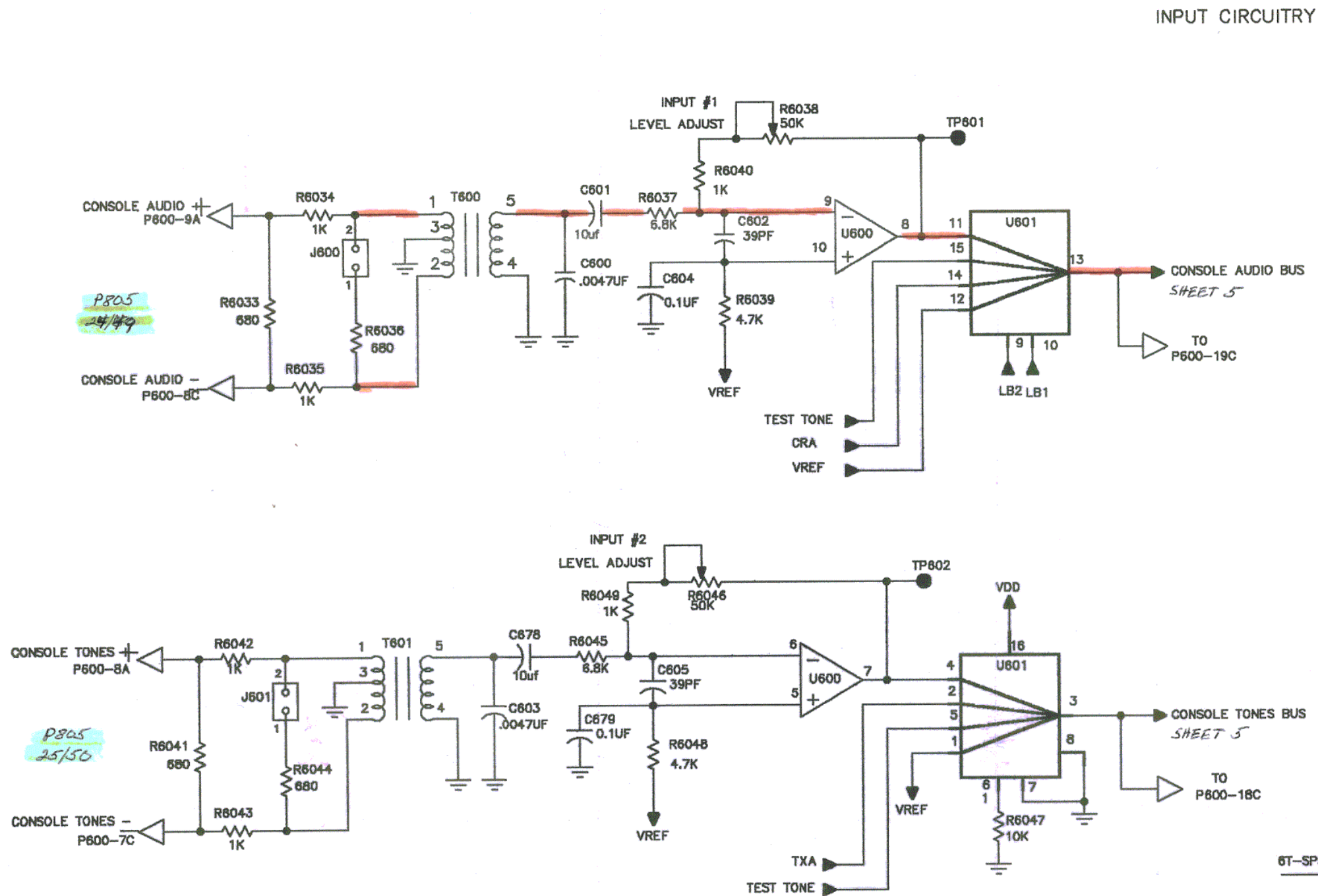
POWER SUPPLY CIRCUITRY



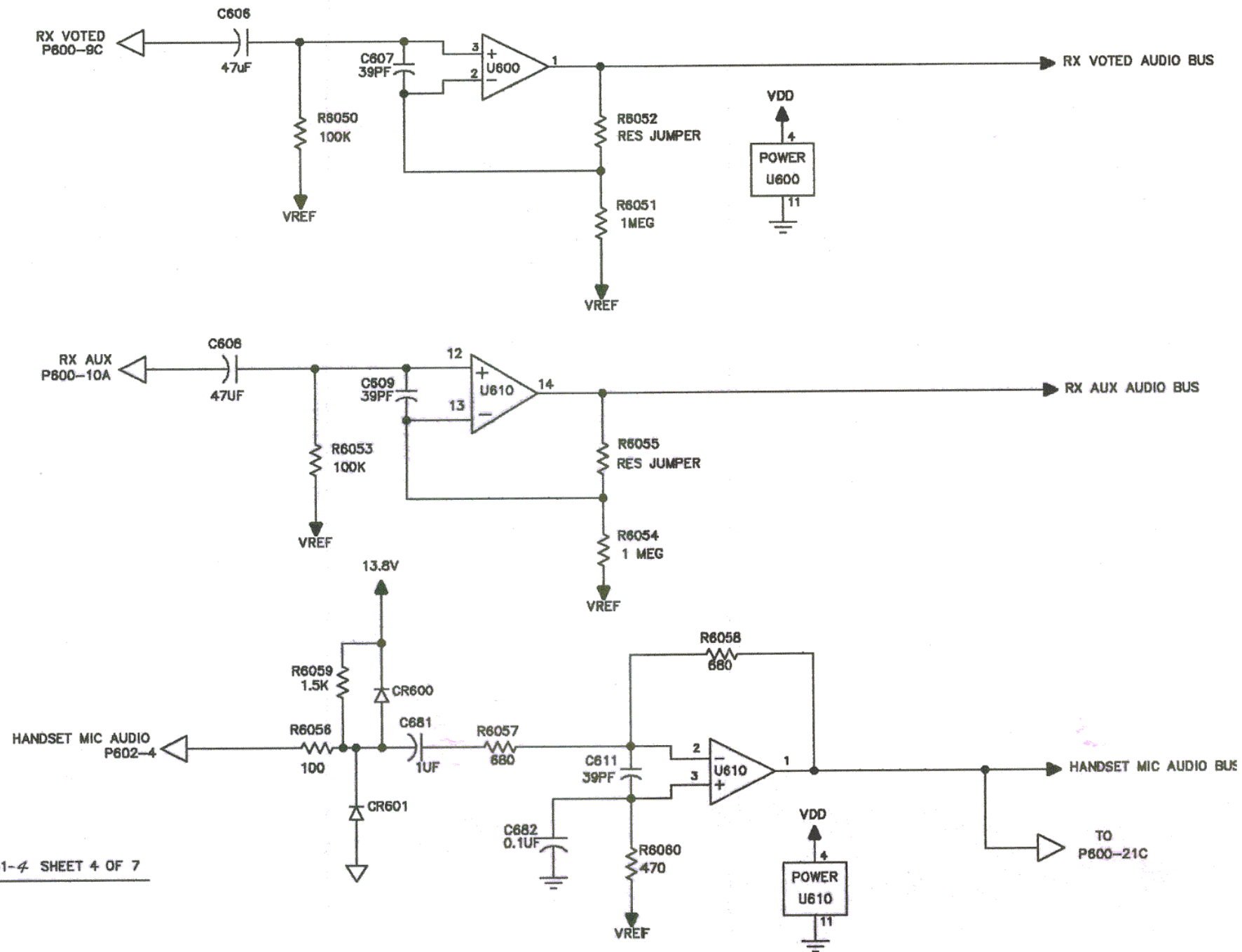
6T-SP5253351-4 SHEET 3 OF 7



QRN4516B Schematic Interconnect Table				
Signal	Sheet 4	Sheet 5	Sheet 6	Sheet 7
CO1		X		X
CO2		X		X
CO3		X		X
COAA		X		X
COCA		X		X
COCT		X		X
CODE		X		X
CODE SEL		X	X	X
COE		X		X
COHM		X		X
CONSOLE AUDIO BUS	X	X	X	X
CONSOLE TONES BUS	X	X	X	X
COS		X		X
COVA		X		X
CRA	X	X		X
CS			X	X
FLTR SEL			X	X
GD1			X	X
GD2			X	X
GG1			X	X
HANDSET MIC AUDIO BUS	X	X	X	X
LB1		X		X
LB2		X		X
MODE			X	X
RX AUX AUDIO BUS	X	X		X
RX VOTED AUDIO BUS	X	X	X	X
SR CLK		X		X
TEC			X	X
TEST NODE 1			X	X
TEST NODE 2	X		X	X
TEST TONE		X	X	X
TET			X	X
TL			X	X
TOE		X		X
TONE SEL		X	X	X
TONES		X	X	X
TX1		X		X
TX2		X		X
TX3	X	X		X
TXA		X		X
TXAA		X		X
TXCA		X		X
TXCT		X		X
TXE		X		X
TXHM		X		X
TXS		X		X
TXVA		X		X



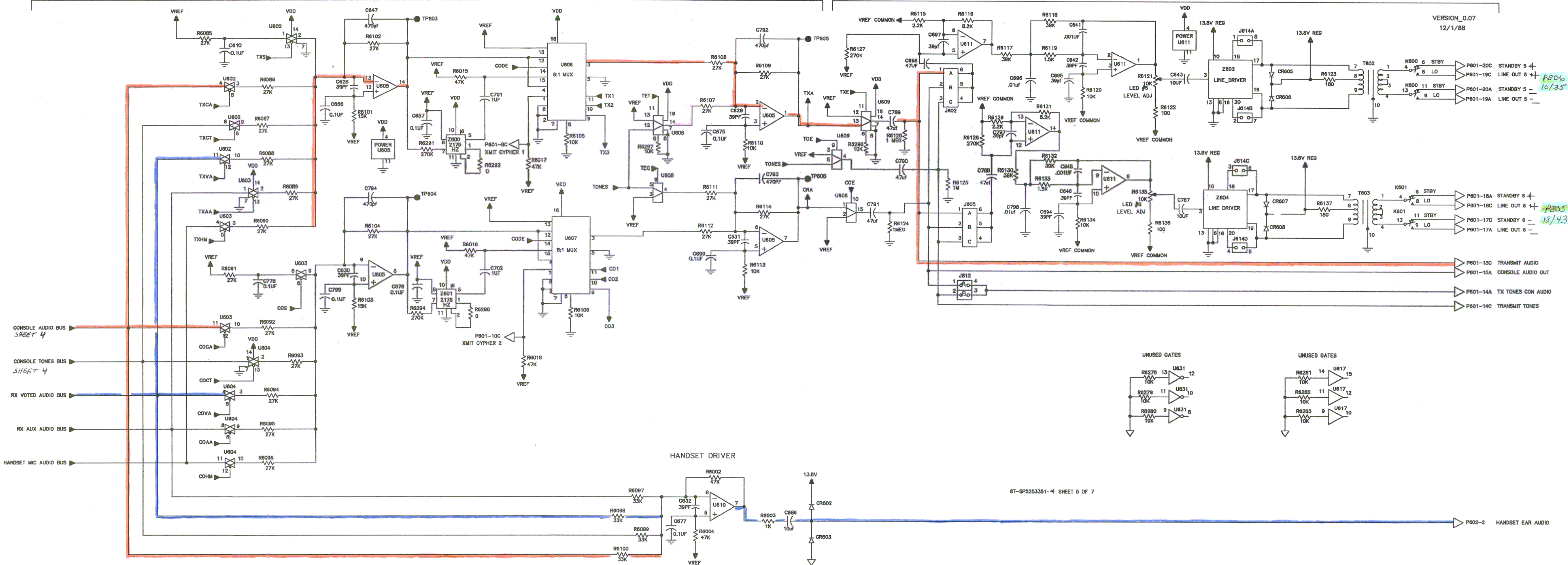
6T-SP5253351-4 SHEET 4 OF 7

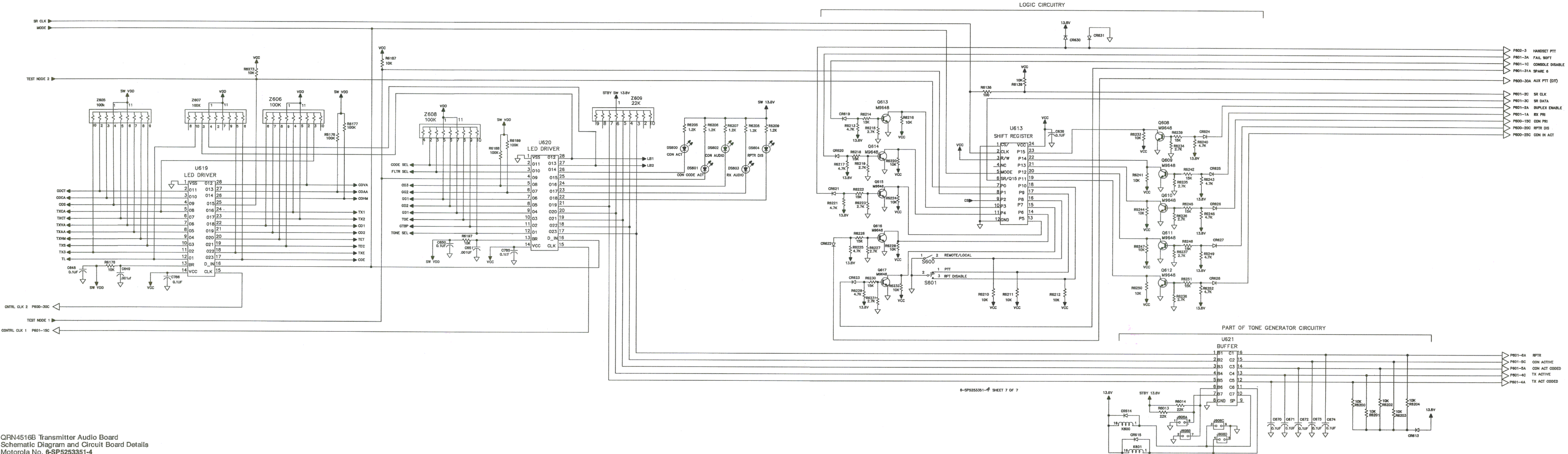


GATING CIRCUITRY

OUTPUT CIRCUITRY

VERSION_0.07
12/1/88





PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed: uF; $\pm 10\%$; 50 V unless otherwise stated
C600	2111032A17	.0047
C601	2311019A20	10 $\pm 20\%$; 25 V
C602	2111031A29	39pf $\pm 5\%$
C603	2111032A17	.0047
C604	2111032A33	0.1
C605	2111031A29	39pf $\pm 5\%$
C606	2311019A40	47 $\pm 20\%$; 25 V
C607	2111031A29	39pf $\pm 5\%$
C608	2311019A40	47 $\pm 20\%$; 25 V
C609	2111031A29	39pf $\pm 5\%$
C610, C612, C614	2111032A33	0.1
C611	2111031A29	39pf $\pm 5\%$
C613	2311019A20	10 $\pm 20\%$; 25 V
C615	2111031A29	39pf $\pm 5\%$
C616	2311019A20	10 $\pm 20\%$; 25 V
C617	2311019A46	100 $\pm 20\%$; 25 V
C618	2311019A20	10 $\pm 20\%$; 25 V
C619	2111032A33	0.1
C620	2311019A20	10 $\pm 20\%$; 25 V
C621	2111032A33	0.1
C622	2311019A20	10 $\pm 20\%$; 25 V
C623	2111032A33	0.1
C624	2311019A20	10 $\pm 20\%$; 25 V
C625	2111032A33	0.1
C626	2311019A20	10 $\pm 20\%$; 25 V
C627	2111032A33	0.1
C628 thru C633	2111031A29	39pf $\pm 5\%$
C634	2311019A20	10 $\pm 20\%$; 25 V
C635	2111031A25	27pf $\pm 5\%$
C636	2111031A49	270pf $\pm 5\%$
C637	2111031A24	24pf $\pm 5\%$
C638	2111032A33	0.1
C639	0811044A33	1.0 $\pm 5\%$; 50/63V
C640	2311019A20	10 $\pm 20\%$; 25 V
C641	2111031A09	.001
C642	2111031A29	39pf $\pm 5\%$
C643	2311019A20	10 $\pm 20\%$; 25 V
C644	2111031A29	39pf $\pm 5\%$
C645	2111031A09	.001
C646	2111031A29	39pf $\pm 5\%$
C647	2111031A55	470pf $\pm 5\%$
C648	2111032A33	0.1
C649	2111031A09	.001
C650	2111032A33	0.1

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C651	2111031A09	.001
C652, C653	2111032A33	0.1
C654	0811044A15	0.1 $\pm 5\%$; 63 V
C655	2111031A29	39pf $\pm 5\%$
C656, C657	2111032A33	0.1
C658	2111031A41	120pf $\pm 5\%$
C659, C660	2111032A33	0.1
C661	2111031A29	39pf $\pm 5\%$
C662	0811044A15	0.1 $\pm 5\%$; 63 V
C663	2111032A33	0.1
C664	0811044A24	.01 $\pm 5\%$; 63 V
C665	0811051A06	.0068 $\pm 5\%$; 63 V
C666	2111032A33	0.1
C667	2111031A55	470 p-p
C668 thru C677	2111032A33	0.1
C678	2311019A20	10 $\pm 20\%$; 25 V
C679, C680	2111032A33	0.1
C681	0811044A33	1.0 $\pm 5\%$; 50/63V
C682, C683	2111032A33	0.1
C684	2311019A20	10 $\pm 20\%$; 25 V
C685	2111032A33	0.1
C686	2311019A20	10 $\pm 20\%$; 25 V
C687 thru C691	2111032A33	0.1
C692, C693	2311019A20	10 $\pm 20\%$; 25 V
C694, C695	2111031A29	39pf $\pm 5\%$
C696	2111032A21	.01
C697	2111031A29	39pf $\pm 5\%$
C698	2311019A40	47 $\pm 20\%$; 25 V
C699	2111032A33	0.1
C700	0811044A14	.068
C701, C702	0811044A33	1
C775, C776, C777	2111031A29	39pf $\pm 5\%$
C778, C779	2111032A33	0.1
C780	2111031A29	39pf $\pm 5\%$
C781	2111032A33	0.1
C782	2113741B21	0.001
C783	2111032A33	0.1
C784	2111031A41	120pf $\pm 5\%$
C785, C786	2111032A33	0.1
C787	2311019A20	10 $\pm 20\%$; 25 V
C788 thru C791	2311019A40	47 $\pm 20\%$; 25 V
C792 thru C794	2111031A55	470pf $\pm 5\%$
C795 thru C797	2111031A29	39pf $\pm 5\%$
C798	2111032A21	.01
C799	2111032A33	0.1
C800	2111015B09	470pf

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
CR600 thru CR616	4811058A11	diode: (see note) silicon
CR618 thru CR632	4811058A11	silicon
DS600	4888245C23	light emitting diode: (see note) yellow
DS601, DS602, DS603	4888245C22	green
DS604	4888245C24	red
J600, J601	2884729L01	connector: male, 2-pin
J602, J605	2884528K09	male, 6-pin
J608	2884528K05	male, 8-pin
J612	2884528K35	male, 4-pin
J614	2884528K05	male, 8-pin
J618	2884528K35	male, 4-pin
K600, K601	8084090N03	relay: 2 amp 12 VDC
P600, P601	0982236R01	connector: female, 96-pin
P602	0983112N01	female, 6-pin
Q600	4800869647	transistor: (see note) PNP
Q601	4811056C09	NPN
Q603	4811056C08	PNP
Q605	4811043C07	NPN
Q606	4800869647	PNP
Q607	4811043C07	NPN
Q608 thru Q617	4811056C09	NPN
Q618	4811056C08	PNP
Q619	4811056C08	PNP
R6000	0611077B23	resistor: fixed: $\pm 5\%$; 1/8 W unless otherwise stated 100k
R6001	0611077B74	1 meg
R6002	0611077B15	47k
R6003	0611097A74	1000
R6004	0611077A90	4700
R6005	0611077B22	91k
R6006	0611077B23	100k
R6007	0611077B31	220k
R6008	0611077A82	2200
R6010	0611077B09	27k
R6011, R6012	0611077A98	10k

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R6013, R6014	0611077B07	22k
R6015 thru R6018	0611077B15	47k
R6033	0611077A70	680
R6034, R6035	0611097A74	1000
R6036	0611077A70	680
R6037	0611077A94	6800
R6038	1883452F17	variabke: 50k $\pm 10\%$; $\frac{1}{2}$ W
R6039	0611077A90	4700
R6040	0611097A74	1000
R6041	0611077A70	680
R6042, R6043	0611097A74	1000
R6044	0611077A70	680
R6045	0611077A94	6800
R6046	1883452F17	variabke: 50k $\pm 10\%$; $\frac{1}{2}$ W
R6047	0611077A98	10k
R6048	0611077A90	4700
R6049	0611097A74	1000
R6050	0611077B23	100k
R6051	0611077B47	1 meg
R6052	0611077A01	0 ohm
R6053	0611077B23	100k
R6054	0611077B47	1 meg
R6055	0611077A01	0 ohm
R6056	0611077A50	100
R6057	0611077A70	680
R6058	0611077A70	680
R6059	0611077A78	1500
R6060	0611077A66	470
R6061	0611077A90	4700
R6062, R6063	0611077A98	10k
R6064	0611077B19	68k
R6065 thru R6067	0611077A98	10k
R6069	0611077A82	2200
R6070	0611077A90	4700
R6071	0611077A94	6800
R6072	0611077A98	10k
R6074	0611077A50	100
R6075	0611077A98	10k
R6076	0611009A41	470; $\frac{1}{4}$ W
R6077	0611077A98	10k
R6078	0611009A57	2200; $\frac{1}{4}$ W
R6079	0611009A43	560; $\frac{1}{4}$ W
R6080	0611009A47	820; $\frac{1}{4}$ W
R6081	0611009A27	120; $\frac{1}{4}$ W
R6082	0611009A05	15; $\frac{1}{4}$ W
R6083	0611077A62	330
R6084	0611077A66	470
R6085, R6096	0611077B09	27k

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R6097 thru R6100	0611077B11	33k
R6101	0611077B03	15k
R6102	0611077B09	27k
R6103	0611077B03	15k
R6104	0611077B09	27k
R6105, R6106	0611077A98	10k
R6107 thru R6109	0611077B09	27k
R6110	0611077A98	10k
R6111, R6112	0611077B09	27k
R6113	0611077A98	10k
R6114	0611077B09	27k
R6115	0611077A82	2200
R6116	0611077A96	8200
R6117, R6118	0611077B13	39k
R6119	0611077A78	1500
R6120	0611077A98	10k
R6121	1883452F32	variable: 10k $\pm 10\%$; $\frac{1}{2}$ W
R6122	0611077A50	100
R6123	0611077A56	180
R6124 thru R6126	0611077B47	1 meg
R6127, R6128	0611077B33	270k
R6129	0611077A82	2200
R6130	0611077B13	39k
R6131	0611077A96	8200
R6132	0611077B13	39k
R6133	0611077A78	1500
R6134	0611077A98	10k
R6135	1883452F32	variable: 10k $\pm 10\%$; $\frac{1}{2}$ W
R6136	0611077A50	100
R6137	0611077A56	180
R6138	0611077A50	100
R6139	0611077A98	10k
R6140	0611077A92	5600
R6141	0611077A90	4700
R6142	0611077B15	47k
R6143	0611077A94	6800
R6144	0611077A98	10k
R6145	0611077B11	33k
R6146	0611077B47	1 meg
R6147	0611077B19	68k
R6151	0611077A74	1000
R6152	0611077B27	150k
R6153	0611077A90	4700
R6154	0611077B27	150k
R6155	0611077B07	22k
R6156	0611077B15	47k
R6157	0611077B03	15k
R6158	0611077B20	75k

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R6159	0611077B20	75k; ¼ W
R6160	0611077B20	75k
R6161	0611077B03	15k
R6162	0611077B04	16k
R6163	0611077B15	47k
R6164	0611077A76	1200
R6165	0611077B03	15k
R6166	0611077A79	1600
R6167	0611077B01	12k
R6168	0611077B11	33k
R6169	0611077A92	6.8k
R6170	0611077A98	10k
R6171	0611077B19	68k
R6172	0611077B13	39k
R6173	0611077B22	91k
R6176, R6177	0611077B23	100k
R6178	0611077A98	10k
R6179, R6180	0611077B23	100k
R6181	0611077A01	0 ohm
R6182	0611077A50	100
R6183, R6184	0611077A50	100
R6185, R6186	0611077B23	100k
R6187	0611077A98	10k
R6188, R6189	0611077B23	100k
R6197	0611077A98	10k
R6200 thru R6204	0611077A98	10k
R6205 thru R6209	0611009A51	1200; ¼ W
R6210 thru R6212	0611077A98	10k
R6213	0611077A90	4700
R6214	0611077B03	15k
R6215	0611077A84	2700
R6216	0611077A98	10k
R6217	0611077A90	4700
R6218	0611077B03	15k
R6219	0611077A84	2700
R6220	0611077A98	10k
R6221	0611077A90	4700
R6222	0611077B03	15k
R6223	0611077A84	2700
R6224	0611077A98	10k
R6225	0611077A90	4700
R6226	0611077B03	15k
R6227	0611077A84	2700
R6228	0611077A98	10k
R6229	0611077A90	4700
R6230	0611077B03	15k
R6231	0611077A84	2700
R6232, R6233	0611077A98	10k

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R6234 thru R6238	0611077A84	2700
R6239	0611077B03	15k
R6240	0611077A90	4700
R6241	0611077A98	10k
R6242	0611077B03	15k
R6243	0611077A90	4700
R6244	0611077A98	10k
R6245	0611077B03	15k
R6246	0611077A90	4700
R6247	0611077A98	10k
R6248	0611077B03	15k
R6249	0611077A90	4700
R6250	0611077A98	10k
R6251	0611077B03	15k
R6252	0611077A90	4700
R6253	0611077A98	10k
R6254	0611077A08	220
R6255	0611047B47	1 meg
R6256	0611077B05	18k
R6257	0611077A90	4700
R6258	0611077B23	100k
R6259	0611077A74	1000
R6260	0611077B15	47k
R6261	0611077A98	10k
R6262, R6263	0611077A90	4700
R6264	0611077B11	33k
R6265	0611077B05	18k
R6266	0611077A90	4700
R6267	0611077B05	18k
R6268	0611077B23	100k
R6269	0611077A82	2200
R6270 thru R6272	0611077A50	100
R6273 thru R6287	0611077A98	10k
R6288	0611077B41	560k
R6289		not used
R6290	0611077B41	560k
R6291	0611077B33	270k
R6292	0611077A01	0 ohm
R6293		not used
R6294	0611077B33	270k
R6295		not used
R6296	0611077A01	0 ohm
R6297 thru R6301	0611077A98	10k
R6302	0611077A50	100
		switch:
S600	4083249K13	toggle, spdt
S601	4083980R10	toggle, sp3t

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
T600, T601	2584007C02	transformer: audio freq.
T602, T603	2583036L01	audio freq.
TP600 thru TP607	2910271A15	test point: terminal pin
U600	5183222M95	integrated circuit: (see note) quad op amp
U601	5184887K67	analog mux/demux
U602, U603, U604	5184887K04	quad bilateral switch
U605	5183222M95	quad op amp
U606, U607	5184887K26	analog mux/demux
U608, U609	5184887K60	2-channel analog mux/demux
U610, U611	5183222M95	quad op amp
U612	5183977M38	DVP interface control
U613	5106472A86	16-bit shift register
U614	5184118K34	3-line to 8-line decoder
U615	5184944N47	programmable timer module
U616	5183222M95	quad op amp
U617	5184704M19	hex level shifter
U618	5183222M95	quad op amp
U619, U620	5180135C08	LED display driver
U621	5183222M75	LED display interface
U622	5184944N47	programmable timer module
U624	5184320A47	+5 V 750ma voltage regulator
U625, U626	5184887K60	2-channel analog mux/demux
U627	5184118K59	dual J-K flip-flop
U628	5184887K60	2-channel analog mux/demux
U629	5184621K11	quad comparator
U630	5184174P71	8-bit A/D converter
U631	5106472A85	inverter
U632	5184944N48	synchronous serial data adapter
VR600, VR601	4882256C72	voltage regulator: (see note) 5 V
VR602	4883461E02	13 V
Y600	4882611M35	crystal: (see note) 3.072 MHz
Z600, Z601, Z602	01802989R41	hybrid: (see note) 2175 notch
Z603, Z604	0182989R29	line driver
Z605 thru Z608	5182142K02	100k $\pm 5\%$
Z609	5182142K06	22k $\pm 5\%$

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		non-referenced items
	4305885J03	nut, hex: 2-56 x 3/16 x 1/16" (4 used)
	0382009T01	screw, machine: 2-56 x 1/2" (4 used)
	0400009777	washer, lock: no. 2 internal (4 used)
	6406935M05	panel, front
	0310943J14	screw, tapping: TT3.5 x 0.6 x 6mm (3 used)
	0210239A03	nut, hex: 4-40 x .250 x .098" (for U624)
	0310129A07	screw, machine: 4-40 x 3/8" (for U624)
	1483820M02	insulator, heat (for U624)
	2682271P01	heat sink (for U624)
	0982808R09	socket, IC: 24-pin (for U613)
	0984728L01	connector, 2-pin; 7 used (used with J600, J601, J602, J605, J612, J614, J618)
	7505295B01	pad, crystal
	8406135N01	board, circuit; transmit audio

NOTE: For optimum performance, diodes, transistors, crystals, and integrated circuits must be ordered by Motorola part numbers.

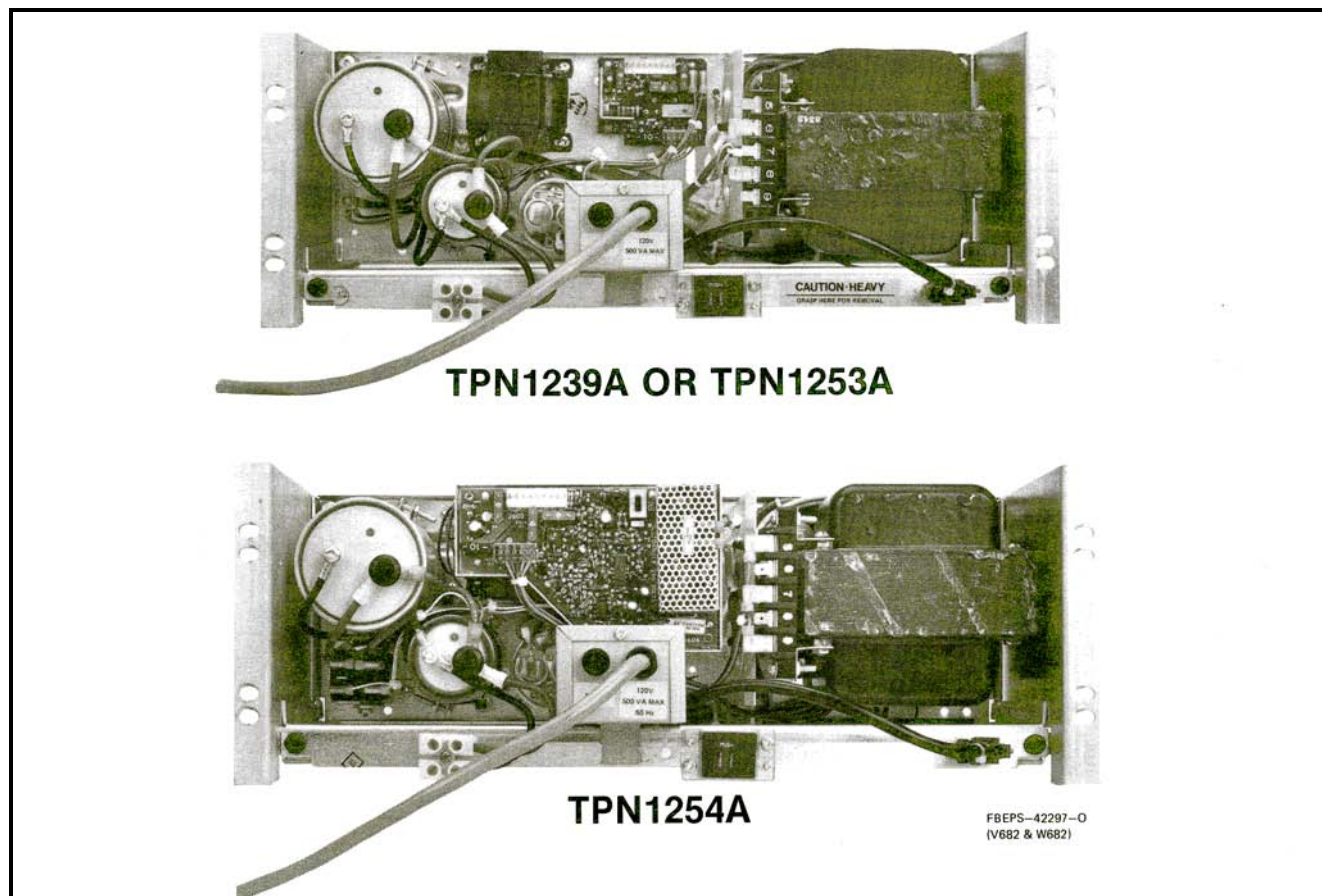


Figure 1. Power Supplies

1. DESCRIPTION (General)

(See Figure 1)

1.1 Models TPN1239A, TPN1253A, and TPN1254A are all high efficiency, solid state, power sources for operation of Fixed Communications equipment installations. These three power supplies are similar in that the main sections (e.g., transformer, rectification and filtering) are electronically the same. These associated power supplies are shown in Figure 1. The output of all these power supplies have high current 14 V dc unregulated and 13.8 V dc regulated outputs.

1.2 The differences between these three power supplies are as follows:

TPN1239A is a standard power supply, which operates at 120/240 V ac at 60 Hz.

TPN1253A is a standard power supply which operates at 120/240 V ac at 50 Hz.

TPN1254A is a standard power supply which operates at 120 V ac 60 Hz and includes a battery back-up/charger circuit.

PERFORMANCE SPECIFICATIONS

GENERAL (all models)

Weight:	12.7 kg (28.13 lbs.)
Operating Temperature:	-30° to +80° C (-22° to +176° F)
Input Voltage:	90 - 140 V ac, 18 - 280 V ac 60 Hz (TPN1239A, TPN1254A) 50 Hz (TPN1253A)
Line Current*:	4.2 A maximum at full rated power supply output
Output Power:	250 Watts
Load Transient:	Shall not drop below 11.5 V dc for a 1.5 A to 19.7 A transient
Output Ripple:	50 mV p-p at 25° to 80° C (77° to 176° F) derate to 100 mV p-p at -30° C (22° F)
Efficiency:	Greater than 76% (full load)
Short Circuit Current:	Approximately 80 A (measured at TB601)

FUSED OUTPUTS (all models)

Main:	13.8 V dc at 4 A
Auxiliary:	13.8 V dc at 10 A

UNFUSED OUTPUT (TB601)

Output Voltage (TPN1254A):	Battery Type (V dc)		
S650 Position	Lead-Acid	NiCad	No Battery
Float:	13.5	14.25	14.25
Equalize:	14.25	15.25	15.25
Output Voltage (TPN1239A, TPN1253A):	12.9 V dc min. (full load) 17.2 V dc (2 A load)		

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

* When calculating primary input power requirements, do not use Line Current to calculate dissipated power. Use a power meter with provisions for non-unity power factor.

POWER SUPPLY
MODEL BREAKDOWN CHART

Kit	Description		
	Power Supply (60Hz)	Power Supply (50Hz)	Battery Charging Power Supply
TPN1239A			
TPN1253A			
TPN1254A			
Kit	Description		
	x		TPN1214A Internal Power Supply (50Hz)
x			TPN1217A Internal Power Supply (60Hz)
		x	TPN1218A Internal Power Supply (Battery Charging)
		x	TPN6137D Power Supply Distribution Board
x	x		TPN6138C Power Supply Distribution Board
x	x		TRN5963A Miscellaneous Hardware
	x		TRN5964A Power Supply Hardware
		x	TRN5965A Battery Charger Hardware
x		x	TRN5968A Power Supply Hardware (250W)
x	x	x	TLN2994A Fuse Box (Power Connection)
x	x	x	TKN8485A Fuse Box Cable
x	x	x	TRN9706A Fuse Box Hardware
x	x	x	TRN9708A Power Supply Mounting Hardware
x	x	x	TRN9795A Fuse Kit
			SMR-5923 3/1/93
x			TPN1217B Internal Power Supply
		x	TPN1218B Internal Power Supply (Battery Charging)
		x	TRN7241B 14 V Battery Charger Board
x			TRN7242A 14 V Power Distribution Board
		x	TRN7275A Hardware, Battery Charger, 65MH
		x	TRN7333A Unique Hardware, 14 V
x			TRN7616A Miscellaneous Hardware
x		x	TRN9752A Hardware and Packing

				Cable Kits	
				TKN8474A	DC Power Cable (Rack Only)
				TKN8477A	External Battery Cable (55AH)
				TKN8472A	Battery Cable (8 AH)
				TKN8473A	Battery Cable (55 AH)

Figure 2 further illustrates these differences in functional blocks.

1.3 All three power supplies contain a ferroresonant transformer for efficiency. The transformer has two primary windings, a high current secondary winding, and a resonant secondary winding. Under normal operation, the current in the resonant secondary winding causes the transformer core to saturate, limiting the transformer output voltage and consequently power, to realize high efficiency in design. Rectifying and filtering the transformer output produces a very stable direct current output.

1.4 The TPN1239A and TPN1253A power supplies contain a power distribution board (TPN6138B). The distribution board consists of four power supply fuses and circuitry for overvoltage protection. The transistorized circuitry senses high dc voltages and automatically adds loading for voltage reduction.

1.5 The TPN1254A Power Supply with Battery Back-Up contains circuitry (Model TRN5966A) to provide automatic switchover of output voltage from the line to an external battery (emerg. power). The external battery circuitry also contains similar circuitry like the power distribution board for overvoltage protection.

2. DESCRIPTION OF OPERATION

(TPN1239A and TPN1253A only)

2.1 TRN5963A POWER SUPPLY CHASSIS

The TRN5963A Power Supply Chassis performs the conversion of ac line voltage to the dc voltages required by the radio. The supply provides rectification, filtering, and regulation. Refer to the functional and schematic diagrams for circuit details.

2.1.1 Rectification and Filtering

The secondary voltage of transformer T601 is rectified by CR601 and CR602. Ground connection for the diodes is provided through the heat sink to chassis. Output filtering is provided by the network of C602, C603, and L601.

2.1.2 Regulation

Line and load regulation is provided by the ferroresonant action in the secondary resonant winding of the power transformer T601. The high voltage winding resonates with C601, causing the secondary output voltage.

2.2 TPN6138B/TRN7242A DISTRIBUTION BRD.

The Distribution Board provides overcurrent and overvoltage protection for power supply. Refer to the functional and schematic diagrams for circuit details.

Secondary voltage fusing is provided by F602 thru F605. Overvoltage protection is provided by a surge protection circuit consisting of Q601 thru Q604. A surge in excess of 18 V causes VR601 to conduct. Forward bias current through R602 and base-emitter junction of Q604, turns on Q604. The other transistors turn on, and the chassis mounted R601 acts as a pull-down load for the line voltage surge.

3. DESCRIPTION OF OPERATION

(TPN1254A only)

3.1 The power supply permits the station to operate from 120 or 220 volt, 60 Hz power normally, but provides continued operation from external 12-volt batteries (emergency power) if the ac power should fail. When ac power is present, the power supply also operates as a battery charger to recharge the batteries.

3.2 The power supply provides an output signal (AC FAIL) whenever a line voltage failure is sensed. The power supply then switches the station to battery power. The AC FAIL signal is normally high. It goes low when a line voltage failure is detected. The output signal may be used to enable an audible alarm or provide a visual indication, depending upon the type of station in which the power supply is installed. In some cases, the signal is routed to station control, for monitoring.

3.3 The power supply also provides an output (OVERVOLTAGE ALARM) that occurs if the charger output voltage rises to a level which might result in damage to the external batteries. The overvoltage alarm output signal is normally high. It goes low when an overvoltage condition is sensed. In the event of an overvoltage alarm, contact a serviceman immediately.

3.4 The OVERVOLTAGE ALARM output signal is used with the supply to disconnect (open) the power supply ac power transformer secondary winding. This causes the rectified ac input to the charger board to be interrupted, and the power supply is switched (by the overvoltage sensing circuit and K650) to battery operation. The overvoltage sensing circuit and K650 can only be reset by disconnecting ac and dc power (if dc power is present) since K650 is held latched by dc current through its coil.

3.5 The batteries used as the external emergency source can be either the nickel-cadmium or lead-acid type. An automotive type battery is not recommended as a permanent emergency dc supply.

3.6 A two-position FLOAT-EQUALIZE, (S650), switch on the battery charger board determines the charging rate of the batteries. The EQUALIZE position increases the charging voltage to restore the

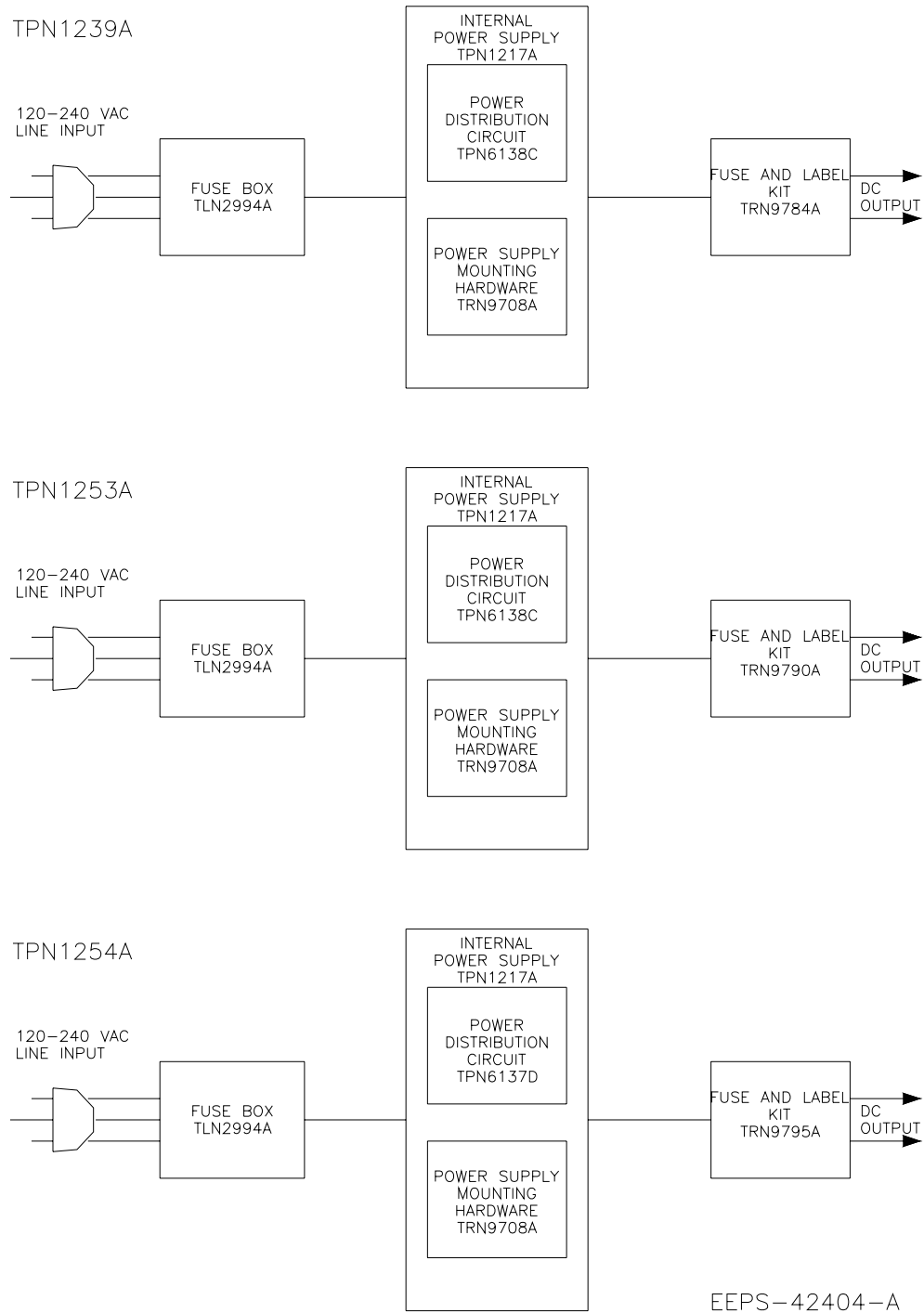


Figure 2. TPN1239A, 53A, & 54A Power Supplies
Simplified Block Diagram

batteries after emergency use or where the condition of the battery dictates. In the other position, FLOAT, a voltage is supplied to the batteries sufficient to maintain them in a fully charged state.

Over-voltage protection is provided by a surge protection circuit consisting of Q601 through Q603 and U601. A surge in excess of 18.5 volts causes voltage at op-amp U601 pin 4 to exceed the reference voltage of 5.1 V at U601 pin 5. The output voltage at U601 pin 2 drops to less than 1 volt causing Q601 to turn on using chassis mounted R651 as a pull-down load for the power supply output. Once the voltage at U601 pin 2 drops, U601 pin 1 goes to a high impedance. This changes the threshold voltage to 14.5 volts. Any subsequent normal use of the station which loads the power supply enough to pull the output voltage down below 14.5 volt threshold (PA key, etc.) will then release R651.

CAUTION

Do not apply an equalization charge to batteries in a discharged condition. A two hour minimum period of float charging is recommended before equalizing voltage is applied after a power failure.

4. THEORY OF OPERATION

(Refer to the functional block and schematic diagrams attached at the end of this section.)

4.1 TRN5968A STANDARD POWER SUPPLY

The TRN5968A performs in a similar manner as the standard power supply chassis, TRN5963A. This supply consists of rectification and filtering circuits. The secondary voltage of ferroresonant transformer T601 is rectified by CR601 and CR602. Ground connection for the diodes is provided through the heat sink to the chassis. Output filtering is provided by C602, C603 and L601.

4.2 TPN5966A BATTERY CHARGER BOARD

Line and load regulation is controlled by the TPN6155A Battery Charger Board. Regulation is accomplished by controlling the saturation of ferroresonant transformer T601 via a control inductor, L650. This inductor is switched across the resonant winding on the transformer as the output voltage reaches a preset level. Potentiometer R662 (VOLT ADJ) permits output voltage adjustment. Switching and timing circuitry of the control inductor is described in the following paragraphs.

4.2.1 Clock Generator

Q665 and Q650 derive a line frequency related clocking signal for timing and triggering purposes.

4.2.2 +10 Volt Reference Source

Zener diode VR650 and diodes CR669 and CR670 establish a +10 volt reference source used by the activity detector, stabilizer, and control voltage generator circuits.

4.2.3 Monostable Switch

U650D converts the clock signal into a monostable pulse, which drives the ramp generator.

4.2.4 Ramp Generator

Q651 generates a ramp voltage in conjunction with C653.

4.2.5 Control Voltage Generator

U650A compares a reference voltage with the output voltage and generates a control voltage with gain to the pulse width modulator.

4.2.6 Pulse Width Modulator

U650C compares the control voltage with the ramp and generates a pulse whose width is determined by how early in the ramp cycle the control voltage equals the ramp voltage.

4.2.7 Stabilizer

U650B keeps the monostable switch (U650D) from changing state for approximately 1/2 cycle to eliminate triggering errors due to line and load transients.

4.2.8 Power Switch

The SCR Q656 and triac Q657 work together to switch the control inductor L650 in and out of the resonant winding on the power transformer. The diode bridge between the SCR and the triac allows the triac to be triggered every half cycle.

4.2.9 Overvoltage Protection

Overvoltage comparator U651A and B compares the voltage appearing at the arm of R662 with a fixed voltage developed across a voltage divider consisting of R678, R683, and R655. Any increase or decrease in A+ voltage is reflected at the arm of R662 and applied to U651A-3. If the A+ voltage at U651A-3 rises above the fixed voltage applied to U651A-2, the output at U651A-1 goes high. This action begins charging

capacitor C659. If the A+ voltage remains high, C659 will charge to a level at the +10 volt reference applied to U651B-5. This causes U651B-7 to go high, which in turn, turns on Q660, Q654, and Q653. Once Q660 and Q664 are turned on, the overvoltage protection relay K650 is energized which removes the transformer secondary center tap return path. Relay K650 will now remain energized until both ac power and battery dc power is disconnected from the station. Similarly, Q653 will remain turned on to provide the overvoltage alarm output at J603-5 until both ac power and battery dc power is disconnected. Zener diode VT651 provides additional protection by forcing the overvoltage circuits to energize in the event that overvoltage sensing through R662 fails.

4.2.10 Line Fail Sense

Q658 and Q659 generate a “line fail” signal when a loss of clock signal is detected. Q658 senses failure at the ac line and Q659 generates the output signal AC FAIL.

4.2.11 Power Up Reset

Q662 and Q661 use the line fail sense signal from Q658 to generate a power up reset input to the pulse width modulator, U650C, each time power is turned on. The power up reset signal is applied to the control voltage input (U650C-9) of the pulse width modulator and enables quick power up.

4.3 TRN7241B BATTERY CHARGER CONTROL BOARD

The TRN7241B Battery Charger Control Board provides line and load regulation for the station power supply. Refer to the attached schematic diagram, circuit board detail and parts list for details.

Regulation is accomplished by controlling the saturation of ferroresonant transformer T601 by way of control inductor L650. This inductor is switched across the resonant winding of T601 as the output voltage reaches a preset level. Potentiometer R662 (VOLT ADJ) permits adjustment of the output voltage from 13.0 to 15.0 volts. Switching and timing circuitry for the control inductor is discussed in the following paragraphs.

4.3.1 5V and 11V Reference Voltages

A 5V reference voltage is generated by the power supply output voltage, R637, R641 and Zener diode VR600. The 5V reference is used in the control voltage generator circuit, over-voltage protection circuits, and optional low voltage battery disconnect circuit. The 11V reference voltage is also generated by the power supply output voltage, R647 and Zener diode VR601.

The 11V reference is used to power U601 and to provide a bias voltage for the ac filter, clock generator and ramp generator circuits.

4.3.2 Secondary AC Filter and Clock Generator

A clock signal at twice the line frequency is generated via the secondary ac signal. The signals are bandpass filtered by U601C and U601D, and the output is compared to a dc bias voltage. As each signal increases above the dc bias voltage, a pulse is generated at the output of U600C and U600D.

4.3.3 Ramp Generator

The clock circuit is used to generate a ramp signal by controlling transistor Q600. The ramp signal is generated by C607, R624 and the reference voltage from Zener diode VR601 in conjunction with Q600.

4.3.4 Control Voltage Generator

U601B compares the 5V reference voltage with a representative power supply voltage generated by U601A. U601B then generates a control voltage with gain to the pulse width modulator.

4.3.5 Pulse Width Modulator

U600B compares the control voltage with the ramp signal and generates a pulse whose width is determined by how early in the ramp cycle the control voltage is equal to the ramp voltage.

4.3.6 Power Switch

SCR Q656 and TRIAC Q657 operate together to switch control inductor L650 in and out of the resonant winding of T601. The diode bridge between the TRIAC and SCR allows the TRIAC to be triggered every half cycle. The pulse width modulator determines the trigger point during each half cycle.

4.3.7 FLOAT/EQUALIZE Switch S650

The EQUALIZE position of S650 allows the battery charger output voltage to be increased by 1 volt for the initial charging and recharging of certain battery types. Refer to the specifications for the battery type being used to determine the charging requirements. The FLOAT position of S650 is used to maintain the battery charge at a constant level. When the temperature compensation option is used, the equalize voltage increment will be 0.5V.

4.3.8 Over-Voltage Protection

The battery charger board contains two over-voltage protection circuits. Resistors R642, R638, R623 and

R615 determine the trigger points of each rail. The first rail is set to trigger at 15.5V and is used to limit the output voltage to 15.5V, independent of the temperature compensation voltage (optional, see paragraph 5.3.10), and output voltage potentiometer R662. Once this rail is triggered, it limits the voltage by turning on Q602. If the main regulator fails, the final rail will trigger at 17V and shut down the power supply output voltage. The station will then revert to battery mode if the batteries are connected and charged. If battery mode is not possible, the station will be inoperable. When U602B is triggered, it turns on SCR Q615, which turns on TRIAC Q606. Q606 then places controlchoke L650 across the ferroresonant winding of T601. **This action may blow the line fuse. This is normal operation. In stations containing two power supplies, the line fuse may not open but rather L650 will remain across the ferroresonant winding** until C615 charges up to a voltage sufficient to trigger Q603 (from 15 to 25 seconds). This cycle repeats until the output voltage falls below 17V. This rail also sends an over-voltage alarm to the station control module signaling a battery charger failure. A service technician should respond immediately.

4.3.9 AC Line Sense Fail

Transistors Q614 and Q616 generate an AC FAIL signal to the station control module when loss of the secondary ac signals is detected.

4.3.10 Temperature Compensation Option

When the temperature compensation option is ordered, a temperature sensing probe is installed near the emergency battery bank, and is connected to the battery charger board connector J604 via the station junction box. The probe generates a temperature-dependent voltage, which is used by U601A to adjust the power supply output voltage. The amount of output voltage change is -39mV per + 1 degree Celsius of temperature change. When installing this option, the normal ambient temperature of the battery room must be determined in order to set the power supply output voltage.

4.3.11 Low Voltage Battery Disconnect Option

This option adds relay K600 to the battery charger board. When the battery bank output voltage drops below 10.25V as measured by U602C, K600 opens and disconnects the emergency batteries from the power supply. In order for K600 to close and re-connect the batteries, the output voltage as measured by U602C, must increase to greater than 11.5V.

5. AC INPUT POWER AND GROUND CONNECTIONS

5.1 INTRODUCTION

Typically these power supplies are shipped from the factory for operation from a 220 V ac power source. However, the power supply may be operated from a 110 V ac power source. Refer to the Initial Power Supply Set-up instructions for details.

5.1.1 All stations should have a separate power circuit from a 5-ampere (minimum), 220-volt ac power source. The power lines should be installed in accordance with local electrical codes. A substantial earth ground must be provided as close to and in as straight a line as possible with the ground terminal provided on the junction box. DO NOT consider the electrical outlet box as a substantial ground. Refer to the Lightning Protection Recommendation sheet, 68P81111E17, for additional grounding recommendations.

5.1.2 The primary ac power line may be installed prior to installation of the cabinet and terminated near the location chosen for the station if the power line cord supplied with the station is to be used. If the station power is to be supplied by conduit wiring, the station must be installed first. Separate procedures are provided for each type of installation in the following paragraphs.

5.2 INITIAL POWER SUPPLY SET-UP

Step 1. Determine the primary power source voltage (110 V ac, or 220 V ac; 50 or 60 Hz).

Step 2. Insure that switch S601 on the power supply chassis is set to correspond with the primary power source voltage.

Step 3. Check the value of the line fuse (F601) located in the junction box. If the primary source voltage is 110 V ac, install the 5 ampere fuse and fuse cap supplied. If the primary source voltage is 220 V ac, install the 2.5 ampere fuse and fuse cap supplied.

Step 4. Check the label on the junction box and make certain it agrees with the primary power source voltage. If not, replace the label with the appropriate label supplied.

5.3 INSTALLATION USING POWER LINE CORD PROVIDED IN THE POWER SUPPLY

Step 1. Install the station as described in the station instruction manual.

Step 2. Connect the male plug of the three-wire ac line cord to the wall outlet provided near the station.

WARNING

Even if a three-wire grounded primary ac power source is available, the radio equipment **must be grounded** separately to prevent electrical shock hazards and provide lightning protection.

NOTE

A power ON-OFF switch is not provided on the station, therefore, the equipment is immediately operational when the power cord is plugged into a live ac outlet.

TKN8485A From Junction Box To Power Supply

Power Connection	International STD Wire Color	US Standard Wire Color
Line	Brown	Black
Neutral	Blue	White
Ground	Green/Yellow	Green

NOTE

The primary power wire colors used conform to international standards. Refer to the above cross reference table as required.

6. OPTIONAL BATTERY CONNECTION AND INSTALLATION

6.1 POWER SUPPLY

6.1.1 Installation of the station with this power supply is standard except for the connection for the 12-volt battery (10 cells nickel-cadmium, 6 cells lead-acid).

WARNING

Potentially explosive gases may be emitted by batteries. Consult system planner N0. R4-2-39 or latest edition before installing battery system. Consult your Motorola Service Representative.

6.1.2 Locate the battery in a secure place, and as close to the station as possible. The cable length must be kept as short as practical, because of the voltage drop in the battery cable. A substantial voltage drop can be developed across this low resistance due to the high currents drawn from the battery while transmitting.

6.1.3 Select a battery location that has an unobstructed air circulation, preferably a cool dry place with ample width aisles to permit easy access to all cells for installation, taking readings, adding water and cleaning. The battery must not be placed near radiators, boilers, or other heat-producing devices.

6.1.4 Capacity of a battery should be carefully determined before its purchase. Factors that influence the capacity are the busy hour load, the protection time desired, the final cell voltage limit and the minimum operating temperatures. For more information contact your Motorola Area Systems Engineer.

6.1.5 Connection of the battery terminals made during installation is extremely important to its service life. If connections are carefully made with clean, acid-free surfaces and kept tight by periodic checking, they will give trouble-free service over the life of the battery.

CAUTION

Do not attach batteries before setting the float voltage.

6.1.6 Adjustment of the float voltage of the power supply is required at the time the battery is installed. The float voltage is the A+ output voltage of the power supply which will keep a battery fully charged when connected across the A+ output terminals. The float voltage adjustment varies with the type of battery being installed and with the ambient temperature. Refer to paragraph 7., A+ Voltage Adjustment, and to the battery manufacturer's literature for adjustment of the float voltage.

6.1.7 Give the battery a freshening or boost charge when it is received. Do this in accordance with the manufacturer's instructions.

6.1.8 Assemble the TKN8477A External Battery Cable per the following procedure:

Step 1. Cut the red and black cables to the shortest length practical for the installation.

Step 2. Do not install the fuse until cable installation is completed.

6.1.9 Connect the battery cable to the battery as follows:

CAUTION

Do not transport with battery installed in tray.

Step 1. Remove the fuse from the battery cable to prevent accidental short circuiting during installation.

CAUTION

Observe proper polarity on battery connection.

Step 2. Connect the battery cable to the left most screw terminals on TB601, located on the power supply, and route the battery cable to the battery connection points.

Step 3. Connect the red wire of the battery cable to the positive (+) terminal of the battery.

Step 4. Connect the black wire of the battery cable to the negative (-) terminal of the battery.

Step 5. Check to assure proper polarity of the cable leads, and then reinstall fuse, removed in Step 1.

6.1.10 If power is to be removed from the station for any reason after the initial installation, the most convenient method is to remove the in-line fuse from the battery cable.

7. A+ VOLTAGE ADJUSTMENT

The A+ output is factory adjusted for nickel-cadmium batteries at 14.25 volts. Refer to the schematic diagram attached at the end of this section. If adjustment is necessary, set output voltage control (**VOLT ADJ**), R662, on the station power supply for the desired float voltage as follows:

Step 1. Disconnect the batteries (if connected) and set **FLOAT-EQUALIZE** switch S650 to the **FLOAT** position.

Step 2. Connect a dc voltmeter with 3% accuracy (or better) between terminals TB601 + and TB601 - on the power supply. Allow the power supply to warm up under nominal/PTT load for at least 10 minutes.

CAUTION

Refer to battery manufacturer's specifications for precise voltage setting required for charging the type of emergency battery to be used. If this information is unavailable, set the charging voltage for the type of battery as specified in Step 3.

Step 3. Set the **VOLT ADJ** control R662 to provide a charging: (a) as specified by the battery manufacturer; (b) of 14.25 volts for nickel-cadmium batteries or; (c) of 13.25 volts for lead-acid batteries.

Step 4. If batteries are not to be used at this time, set **VOLT ADJ** control R662 to provide a voltage of 14.25 volts and then set the **FLOAT-EQUALIZE** switch to the **EQUALIZE** position.

8. MAINTENANCE

8.1 INTRODUCTION

Maintenance and repairs of this power supply demand a thorough understanding of its operation. Refer to the power supply Theory of Operation for this information.

8.2 TEST EQUIPMENT REQUIRED

The following test equipment is necessary for efficient, accurate servicing in the event that maintenance is required.

- 3 ½ digit DVM
- DC current meter (0-50 amperes)
- Load resistor (variable from 0 ohm to 15 ohms, and capable of carrying 50 amperes)
- Variable voltage ac line transformer (0-140 volts or 180 to 280 volts)
- Oscilloscope
- Variable power supply
- Bench service cord consisting of:

Qty.	Part No.	Description
1	15-83183N01	Housing
2	39-83145N01	Contact
1	39-83145N02	Contact
1	30-865903	Cord

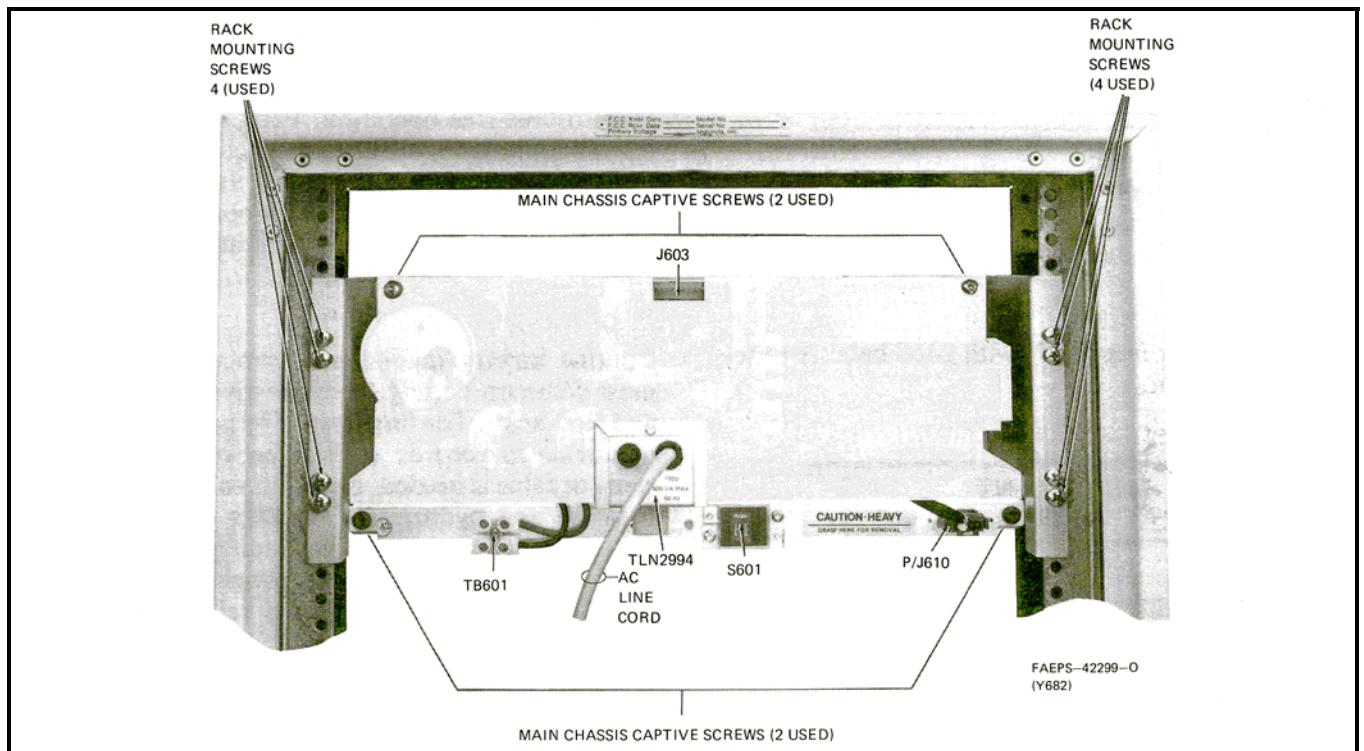


Figure 3. Power Supply Mounting Hardware and Electrical Connections

8.3 POWER SUPPLY REMOVAL

WARNING

The power supply is unexpectedly heavy, balances sharply to the right, and is awkward to hold. Follow the removal instructions carefully.

Step 1. Refer to Figure 3. Disconnect ac plug to the power supply junction box. Disconnect battery cable (if necessary) and dc power cable from the + and - terminals of TB601 on the power supply chassis. Note the color coding of the wires and the polarity of the terminals. If necessary, tag the wires for ease of identification.

Step 2. Refer to Figure 3. Remove main chassis captive screws.

Step 3. Slide power supply chassis toward you until chassis is flush with cabinet as shown in Figure 4.

WARNING

DO NOT ALLOW CHASSIS TO SLIDE FREELY BEYOND FRONT OF CABINET. CABINET RAIL SUPPORTS ENDS ABRUPTLY.

Step 4. Grip the main chassis with the right hand as shown in Figure 5. Find a comfortable grip around the flattened parts of the metal. Adjacent parts have sharp edges.

Step 5. Plant your feet firmly with good balance to receive a heavy weight.

IMPORTANT

Note wrist position in Figure 5.

Step 6. Slide the power supply toward you. Slightly tilt the chassis toward you and reach the left hand under the bottom to balance the chassis on the cabinet rails. Press the chassis firmly against the rails for the chassis will suddenly slide out of the cabinet.

Step 7. Reposition the left hand from balancing the chassis to a firm grip.

Step 8. Brace your body to receive a heavy weight, and lift the power supply chassis free of the cabinet.

Step 9. Re-install the power supply by reversing the removal procedure.

8.4 BATTERY MAINTENANCE

The battery or batteries used for emergency power require certain routine maintenance procedures to assure long trouble-free operation. Persons servicing the batteries should refer to the manufacturer's recommendation for routine maintenance. In addition, certain maintenance procedures are

appropriate following each interval of emergency power operation.

Routine battery maintenance procedures for the two most common battery types are given (nickel-cadmium and lead-acid). The importance of keeping good maintenance records cannot be over-emphasized. A chart or table is needed, listing all voltage readings, temperature and hydrometer readings (where applicable), versus the dates on which the readings were taken. To be most effective, the battery report charts should be kept at the battery location for ready reference.

WARNING

Potentially explosive gases may be emitted by battery. Consult system planner No. R4-2-39 or latest edition before installing battery system. Contact your Motorola Service Representative.

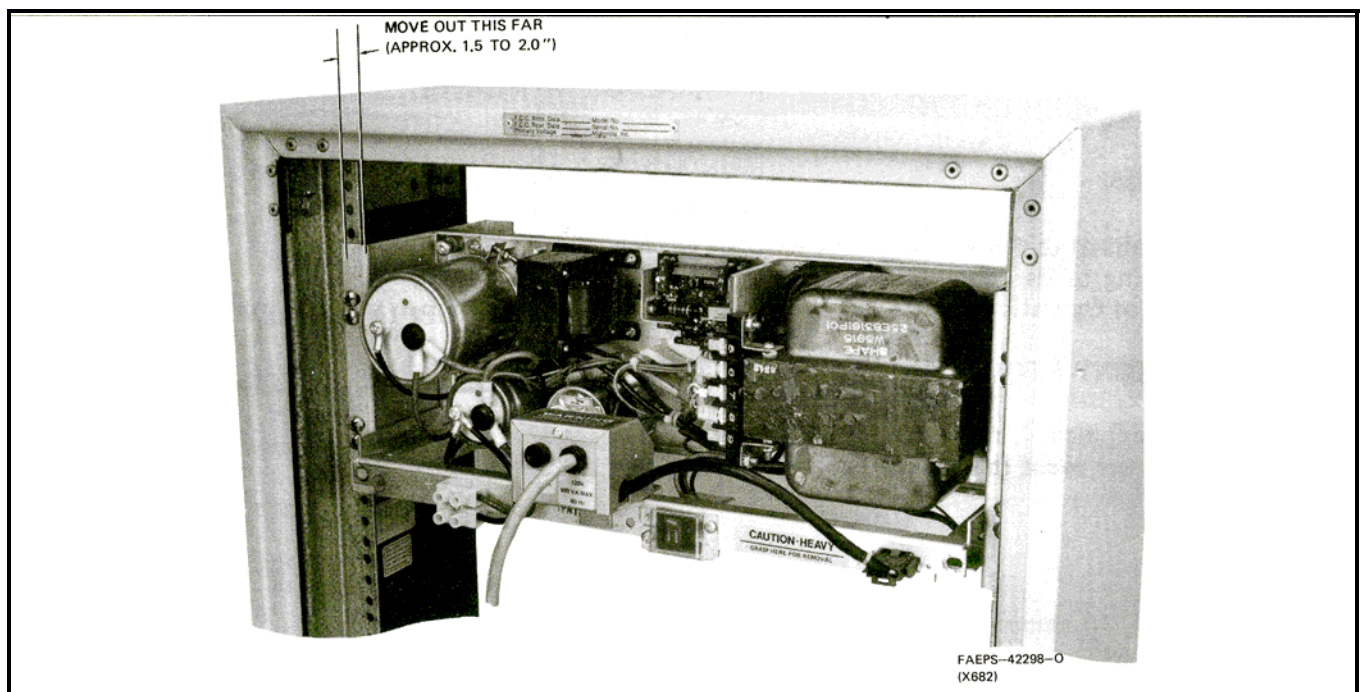


Figure 4. Power Supply Chassis Travel Distance

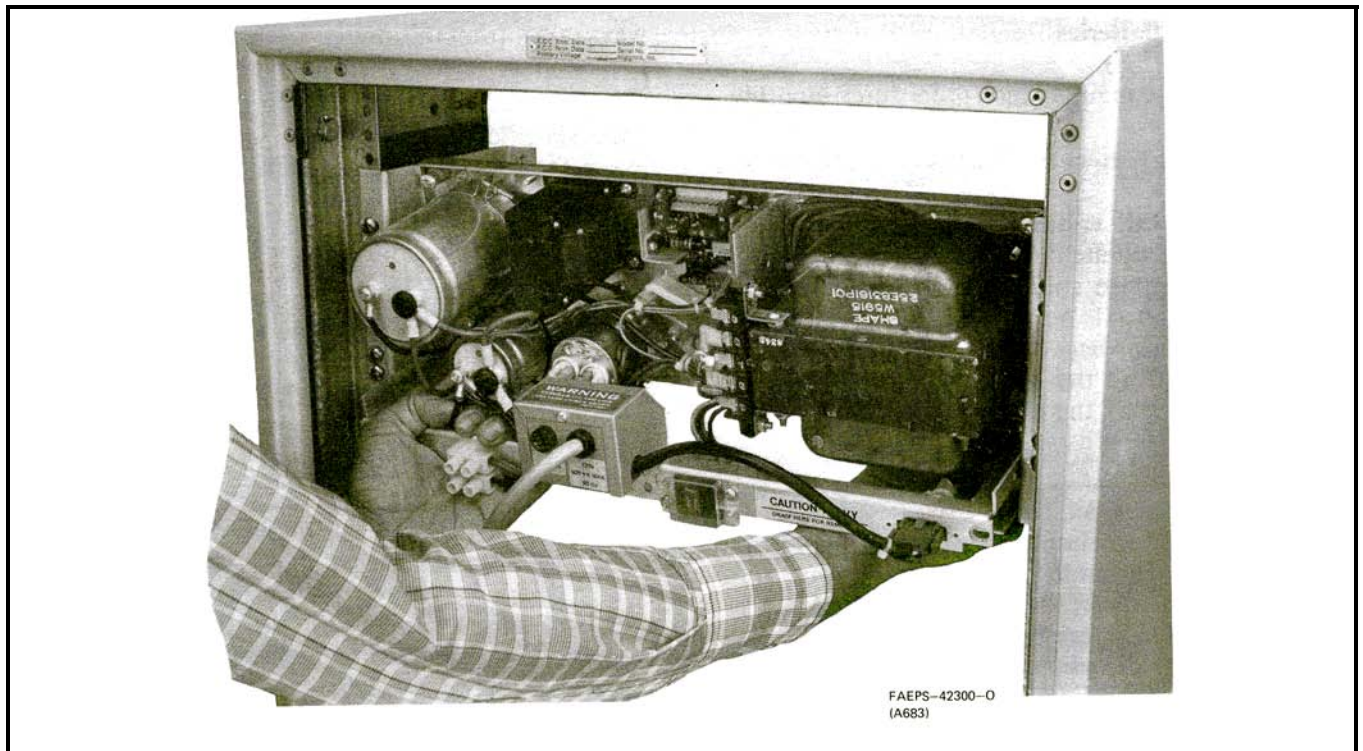


Figure 5. Properly Gripped Chassis

CAUTION

Do not transport with battery installed in tray.

8.4.1 Nickel-Cadmium Batteries (Ni-Cad)

Perform the following routine maintenance procedures at six months intervals.

Step 1. Clean the battery and inspect it for damage.

Step 2. Measure cell voltages and enter the voltage readings on your maintenance report.

Most maintenance schedules require voltage readings of every cell each time maintenance is performed. If a difference of .05 volt or more exists between any two cells, apply an "equalizing charge" to the battery for 48 hours or until three consecutive cell measurements show no change (readings to be taken at ½-hour intervals). The terminal voltage of the battery should then read 15.25 ± 0.2 volts.

CAUTION

Do not apply an equalizing charge to batteries in a discharged condition. A two hour minimum period of float charging is recommended before equalizing voltage is applied after a power failure.

Step 3. Add water as required to keep the electrolyte solution in each cell above minimum. Use distilled water only. Check the battery manufacturer's service literature for instructions on filling.

CAUTION

Do not use any tools on a nickel-cadmium battery, which may have been used with lead-acid batteries. To do so may destroy the nickel-cadmium battery due to chemical contamination by electrolyte or other foreign matter from the lead-acid battery existing on the tool in question.

If frequent replacement of water is required, the charging rate may be too high. In this case, check the A+ voltage with **FLOAT-EQUALIZE** switch S650 in the float position. The A+ voltage reading should agree with the manufacturer's recommended voltage setting for the type of emergency battery being used.

If the manufacturer's recommendations are not available, set the A+ voltage to 14.25 volts. Under certain conditions, the battery may require water even though the charging voltage is correct. In this case, the charging voltage should be reduced until infrequent addition of water is required.

8.4.2 Lead-Acid Batteries

Perform the routine maintenance procedures monthly.

Step 1. Clean the battery and inspect it for damage.

Step 2. Measure cell voltages and enter the voltage readings on your maintenance report. Most maintenance schedules require voltage readings of every cell each time maintenance is performed. If a difference of 0.5 volt or more exists between any two cells, apply an "equalizing charge" to the battery for the number of hours recommended by the manufacturer.

CAUTION

Do not apply an equalizing charge to batteries in a discharged condition. A two hour minimum period of float charging is recommended before equalizing voltage is applied after a power failure.

Step 3. Take specific gravity readings with a hydrometer calibrated for the type of electrolyte used.

Step 4. Observe the necessary precautions to see that no chemical contamination of the cells occurs, and to prevent bodily injury from contact with the electrolyte.

Step 5. After taking a reading, always return the electrolyte in the hydrometer syringe to the cell from which it came. (Failure to do so will decrease the specific gravity of the cell when water is added to fill up the cell.)

Step 6. For an accurate comparison with "standard" specific gravity readings, as published in manufacturer's specifications, a correction factor must be applied to all readings to normalize them with the standard values, when taken at temperatures other than 77° Fahrenheit. However, if the battery

temperature tends to be the same each time specific gravity readings are taken, a trend toward a change in specific will be apparent without having to apply the correction factor to the readings.

The correction factor is easily applied, due to a linear relationship between changes in temperature and specific gravity above and below 77° F. For each three degrees above 77° F, add .001 (known as 1\ "1 point") to the "standard" value of specific gravity. Conversely, for each three degrees below 77° F, subtract 1 point.

Step 7. Take a specific gravity reading of the "pilot cell" monthly. It is not necessary to continually check the specific gravity of all cells, because any gradual changes usually occur simultaneously in all cells. One cell is therefore chosen and designated the "pilot cell", and the monthly routine specific gravity readings are always taken from this one cell. (Be sure to indicate on the maintenance chart which cell is the pilot cell.)

Take specific gravity readings of all the battery cells every three months, and record them on the maintenance chart.

Step 8. Add water as required to keep the electrolyte solution in each cell up to a minimum level should be between the high- and low-level marks on the inside of each cell. If the cells have no such markers, check the manufacturer's literature. *Use distilled water only.*

CAUTION

Do not use any tool on a lead-acid battery, which may have been used with nickel-cadmium batteries. To do so may destroy the lead-acid battery, due to chemical contamination by electrolyte or other foreign matter from the nickel-cadmium battery existing on the surface of the tool in question.

If frequent replacement of water is required, the charging rate may be too high. In this case, check the A+ voltage with the **FLOAT-EQUALIZE** switch S650 in the **FLOAT** position. The A+ voltage reading should agree with the manufacturer's recommended voltage setting or the type of emergency battery being used. If the manufacturer's recommendations are not available, set the A+ voltage to 13.25 volts. Under certain high ambient temperature conditions, the battery may require frequent water replacement even though the correct charging voltage is maintained. In this case, the specified 13.25 volts may be reduced until infrequent water replacement is achieved.

CAUTION

Do not apply an equalizing charge to batteries in a discharged condition. A two hour minimum period of float charging is recommended before equalizing voltage is applied after a power failure.

- if the difference in voltage between any two cells is .05 volt or more,
- as part of each monthly routine maintenance procedure independent of any of the previous conditions stated.

Step 9. Equalize charging of a lead-acid battery should be performed under any one of the following conditions:

- following each known use (or discharge) of the battery,
- if the specific gravity of the pilot cell or any other cell is more than ten-thousandths (10 points) below its full-charge value,

Equalize charging should continue for : (a) the number of hours specified by the battery manufacturer, which will vary according to temperature, charging voltage and manufacturer's recommendations or ; (b) until three successive readings of cell voltage and specific gravity show *no change* (readings to be taken at ½ hour intervals).

9. TROUBLESHOOTING CHART

Symptom	Action
A. No Output Voltage	1. Check primary line connection to supply. 2. Check for transformer secondary voltage at TB602. 3. Check for continuity through relay. 4. Check power rectifiers CR601 and CR602.
B. Relay pulls in when power is applied.	1. Check RELAY DRIVER and RELAY LATCH transistors (Q654 and Q660). 2. Check OVERVOLTAGE COMPARATOR for proper levels. 3. Check for trigger pulses at pin 8, U650C a) If no trigger present, check for proper signals from RAMP GEN, back to CLOCK GEN. If proper signals are present, check voltages at STABILIZER and CONTROL VOLTAGE GEN. b) If correct trigger pulses are present, check power switching circuitry (Q656 through Q657).
C. A+ output voltage too high and cannot adjust.	Check for trigger ouluses at pin 8, U650C. 1. If no trigger present, check for proper signals from RAMP GEN, back to CLOCK GEN. If proper signals are present, check voltages at STABILIZER and CONTROL VOLTAGE GEN. 2. If correct trigger pulses are present, check power switching circuitry (Q656 through Q657).
D. A+ ouput voltage too low.	1. Check for trigger pulses at pin 8, U605C. a) If no trigger present, check for proper signals from RAMP GEN, back to CLOCK GEN. If proper signals are present, check voltages at STABILIZER and CONTROL VOLTAGE GEN. b) If correct trigger pulses are present, check power switching circuitry (Q656 through Q657). 2. Check power diodes CR601, CR602.
E. Output voltage slumps excessively on transmit	1. Check C601

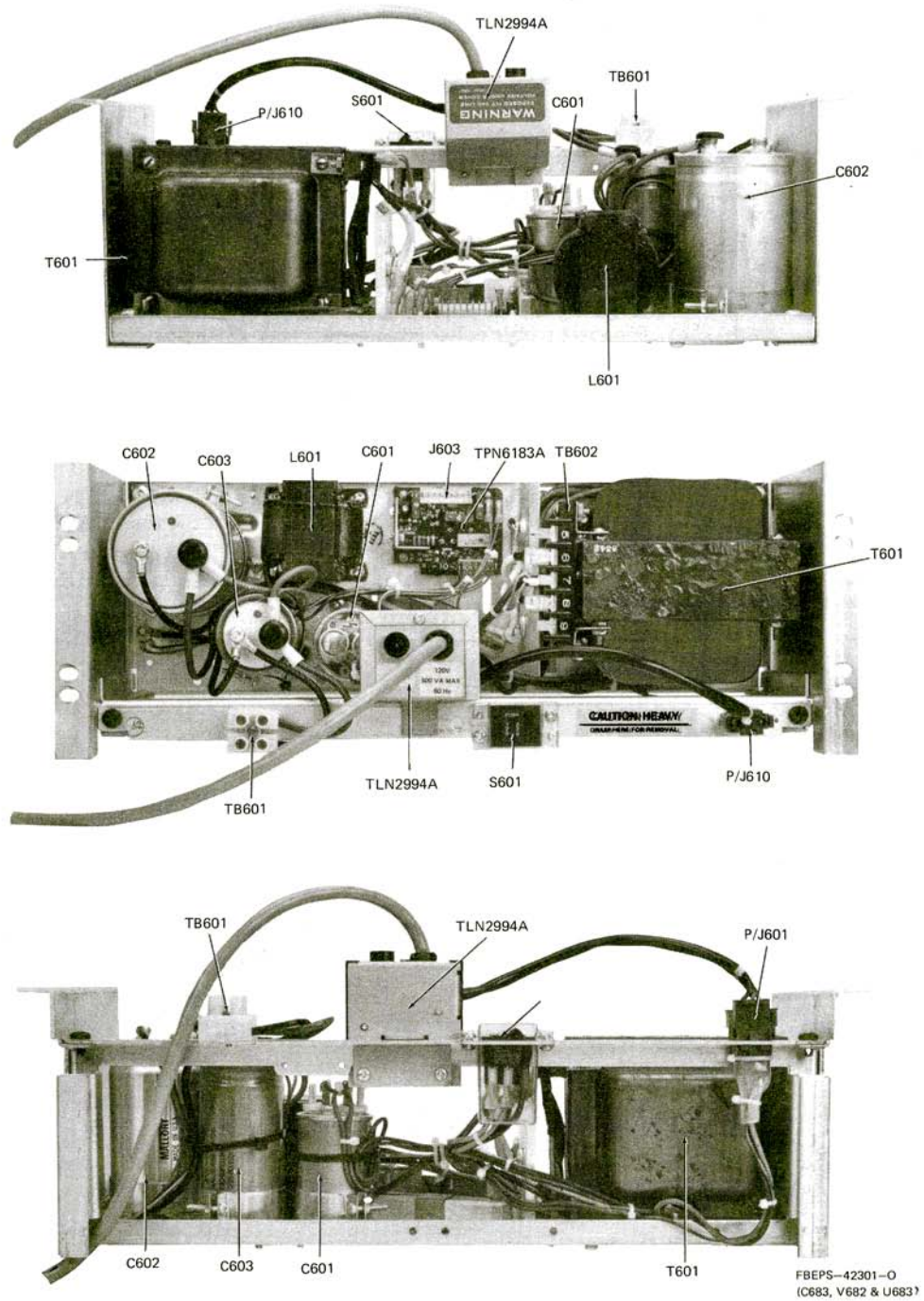


Figure 6. Mechanical Parts Locations
(TPN1239A and TPN1253A only)

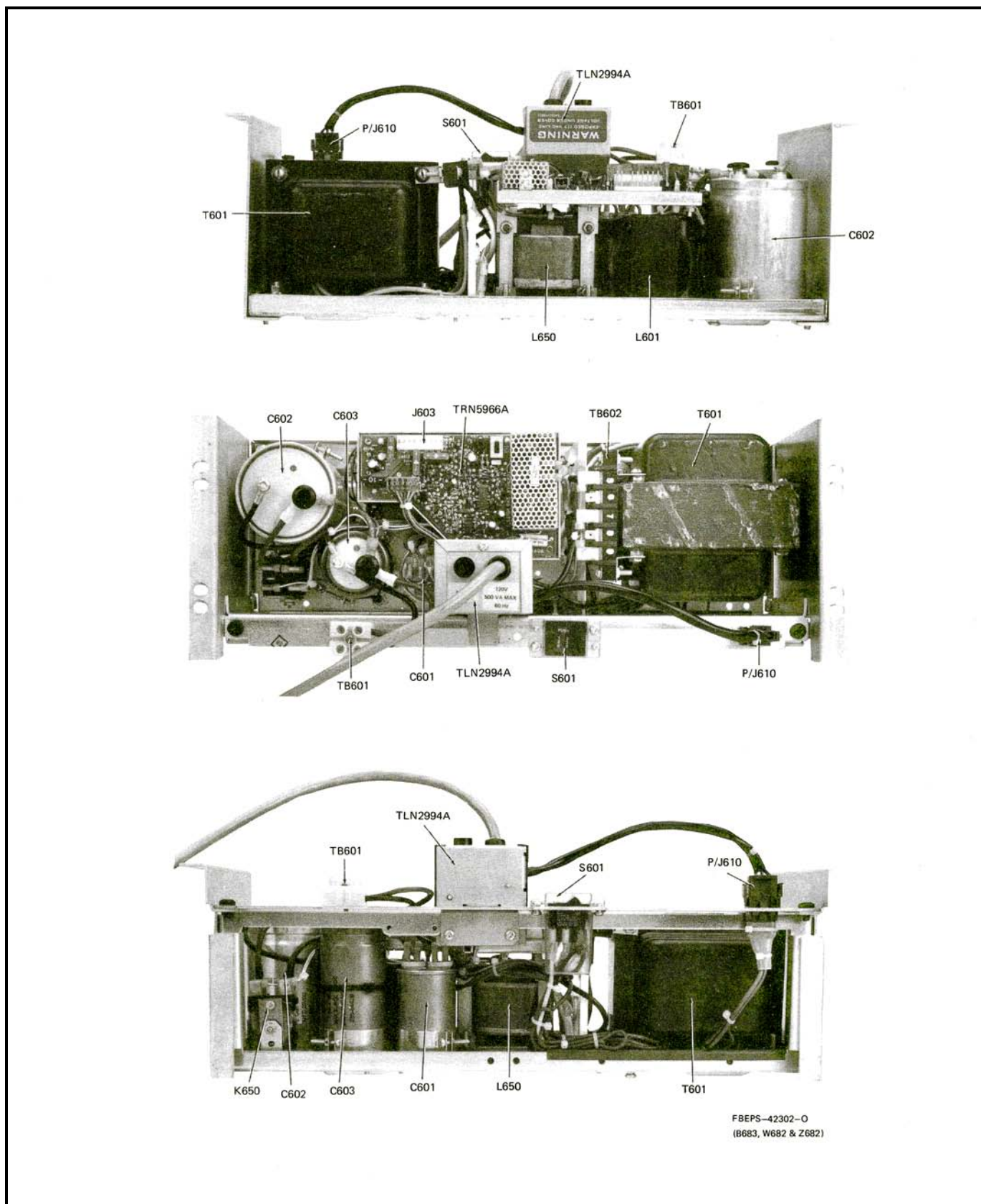
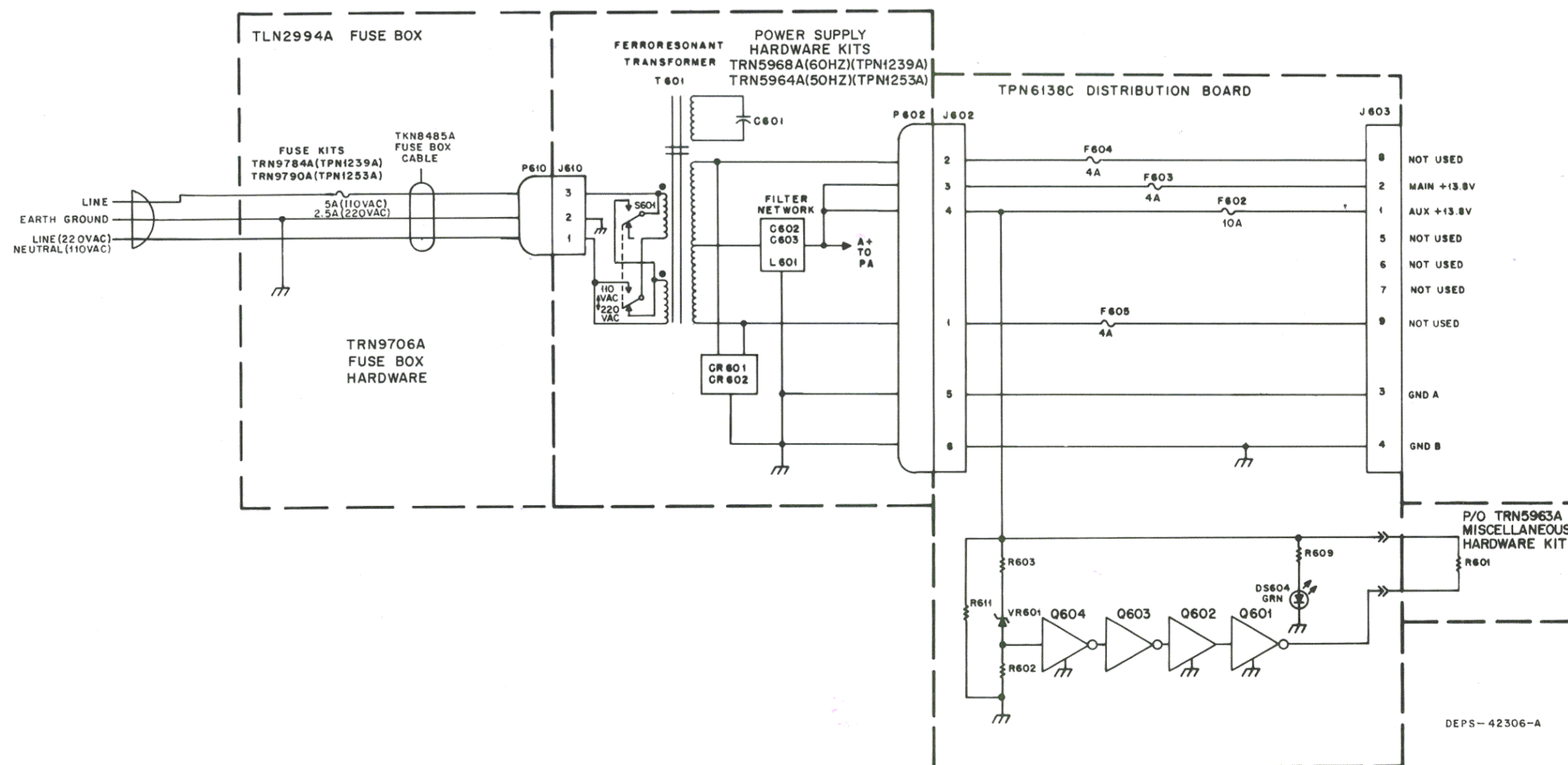


Figure 7. Mechanical Parts Locations
(TPN1254A only)

POWER SUPPLY

FUNCTIONAL BLOCK DIAGRAM

MODELS TPN1239A TPN1253A



POWER SUPPLY
CIRCUIT BOARD DETAIL
AND PARTS LISTS
MODELS TPN1239A
AND TPN1253A

parts list

TRN5964A Power Supply Hardware Kit (250 W) PL-8666-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C601	0882682N03	capacitor, fixed: 15 uF \pm 6%; 330 V ac
C602	2382681N03	97,000 uF \pm 75-7%; 20 V
C603	2382681N06	73,500 uF \pm 75-10%; 20 V
CR601,602	4882732C09	diode: (see note) silicon
P602	0983360N01	connector, receptacle: female; 6 contact
L601	2582620P01	coil: choke; 1.1 mH
S601	4084612B05	switch: rocker, dpdt
T601	2583071P01	transformer: power: 260 W; 60 Hz
TB601	3183576K02	terminal, board: 2-terminals
mechanical parts		
0210971A19		NUT, M6 \times 1 hes; 2 used
0400119331		LOCKWASHER, 1/4" split; 2 used
0483423R01		WASHER, flat rectangular; 2 used
0210971A17		NUT, machine: M4 \times 0.7 hex; 4 used
0210971A18		NUT, machine: M5 \times 0.8mm; 2 used
0310908A55		SCREW, machine: M6 \times 1 \times 25; 4 used
0310943M29		SCREW, tapping: TT5 \times 0.8 \times 13mm; 2 used
0383497N01		SCREW, machine: M4 \times 0.7; 3 used
0383497N02		SCREW, terminal; M5 \times 0.8 \times 12 mm; 4 used
0383498N04		SCREW, tapping: M4 \times 0.7 \times 7; 17 used
0383678N02		SCREW, tapping; M3 \times 0.5 \times 5mm
0400135873		WASHER, flat: 0.281 \times 0.750 \times .060mm; 2 used
0400007651		LOCKWASHER, #8 internal; 10 used
0483499N01		WASHER, insulator; 2 used
0400007658		LOCKWASHER, #10 internal; 6 used
0582904N01		GROMMET; 4 used
1483277N01		INSULATOR, lug; 2 used
1484088N01		INSULATOR, cap terminals; 2 used
1484548A01		INSULATOR, washer; 2 used
1582659P01		COVER, switch; front
1582660P01		COVER, switch; rear
2683005P01		HEAT SINK
2783040P01		chassis, power supply
2982607B05		LUG, ring; 2 used
2983376H05		LUG, receptacle; 2 used
2982907N06		TERMINAL, ring; 2 used
2983113N03		TERMINAL, right angle; 2 used
2983137N01		TERMINAL, splice; 2 used
3983146N01		CONTACT, socket
4276724		CLAMP, cable; 2 used
4210217A02		STRAP, tie; .091 \times 3.62; 15 used
4235424B03		STRAP, tie: .094 \times 14; 15; 2 used
4282903N01		CLAMP, cap; 2"
4282903N04		CLAMP, cap: 1-3/4"; 2 used
4282903N03		CLAMP, cap; 3"
5482885P02		LABEL, switch
5483971N01		LABEL
5484046N01		LABEL
2982607B06		TERMINAL, ring
383498N05		SCREW, tapping; M4 \times 0.7 \times 12; 2 used
310943M25		SCREW, tapping; M4 \times 0.7 \times 20
2982607B05		TERMINAL, ring; 3 used
2982907N05		TERMINAL, ring (yel)
7583056P01		PAD, snap on

TRN5963A Miscellaneous Power Supply Hardware Kit PL-8664-B

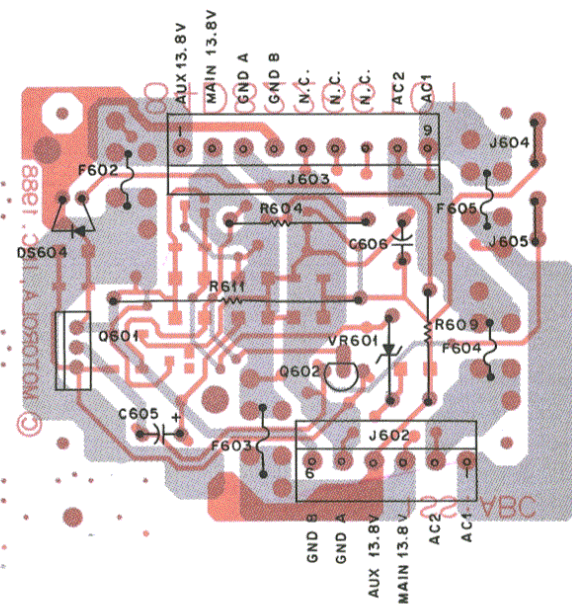
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R601	17-82177B63	resistor, fixed: 10 \pm 10%; 50 W
non-referenced items		
	29-83113N03	TERMINAL, right angle; 4 used
	3-83498N04	SCREW, tapping; M4 \times 0.7 \times 7mm
	4-7633	WASHER, flat
	43-82980N03	STANDOFF, support; 4 used
	29-82907N05	TERMINAL, ring (YEL)
	29-83376H05	LUG, receptacle

TPN6138C Power Supply Distribution Board PL-11394-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C605	2311019A27	capacitor, fixed: 22uF \pm 20% 25V
C606	0811051A07	.01uF \pm 5% 63V
C607 thru 611	2113740B32	20pF \pm 5% 50V
CR603	4811058A11	diode: (see note) silicon
DS604	4884404E04	light emitting diode: (see note) green
F602	6500139767	fuse: 10A 32V
F603 thru 605	6582859N01	4A 32V
J602	2882984N06	connector: male: 6-contact
J603	2882984N14	male: 9-contact
J604,605	2910231A10	lug, terminal
Q601	4800869806	transistor: (see note) NPN type M9806
Q602	4800869568	NPN type M9568
Q603	4811056A08	PNP type M56A08
Q604	4811056A09	NPN type M56A09
R602	0611077A50	resistor, fixed: \pm 5% 1/8W unless otherwise stated
R603	0611077A62	100
R604	0611086C47	330 2W
R605 thru 608	0611077A94	6.8k
R609	0611086A61	1.2k 1W
R610	0611077A60	270
R611	1782177B08	200 \pm 10% 5W
VR601	4883696E05	voltage regulator: (see note) Zener: 16V
non-referenced items		
	0210971A16	NUT, machine: M3x0.5; for Q601
	0383497N04	SCREW, machine:M3x0.5x; for Q601
	0484152B01	WASHER, shoulder: for Q601
	1483820M02	INSULATOR, heat conductive: for Q601
	1584576N01	SHROUD, fuse clip: 4 used
	2684012N01	SHIELD, amplifier: for Q601
	2982906N01	TERMINAL, fuse: 8 used
	5483865R01	LABEL, bar code

note: For optimum performance, diodes, transistors, and integrated circuits must be ordered by Motorola part numbers.

TPN6138C POWER SUPPLY DISTRIBUTION BOARD
(CURRENT VERSION)



COMPONENT SIDE ● BD-BEPS-46970-0
SOLDER SIDE ● BD-BEPS-46971-0
OL-CEPS-46972-0

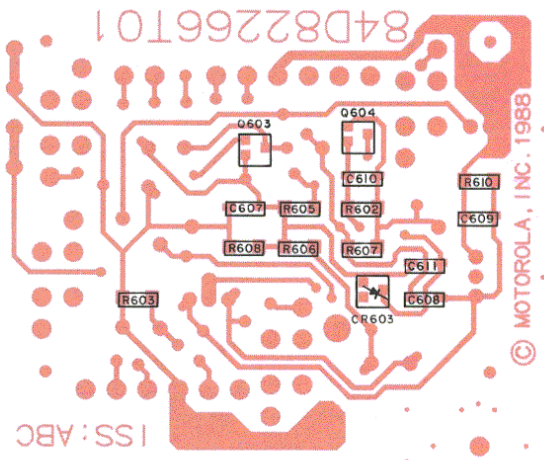
SHOWN FROM COMPONENT SIDE



Q601 (NPN)
TOP VIEW



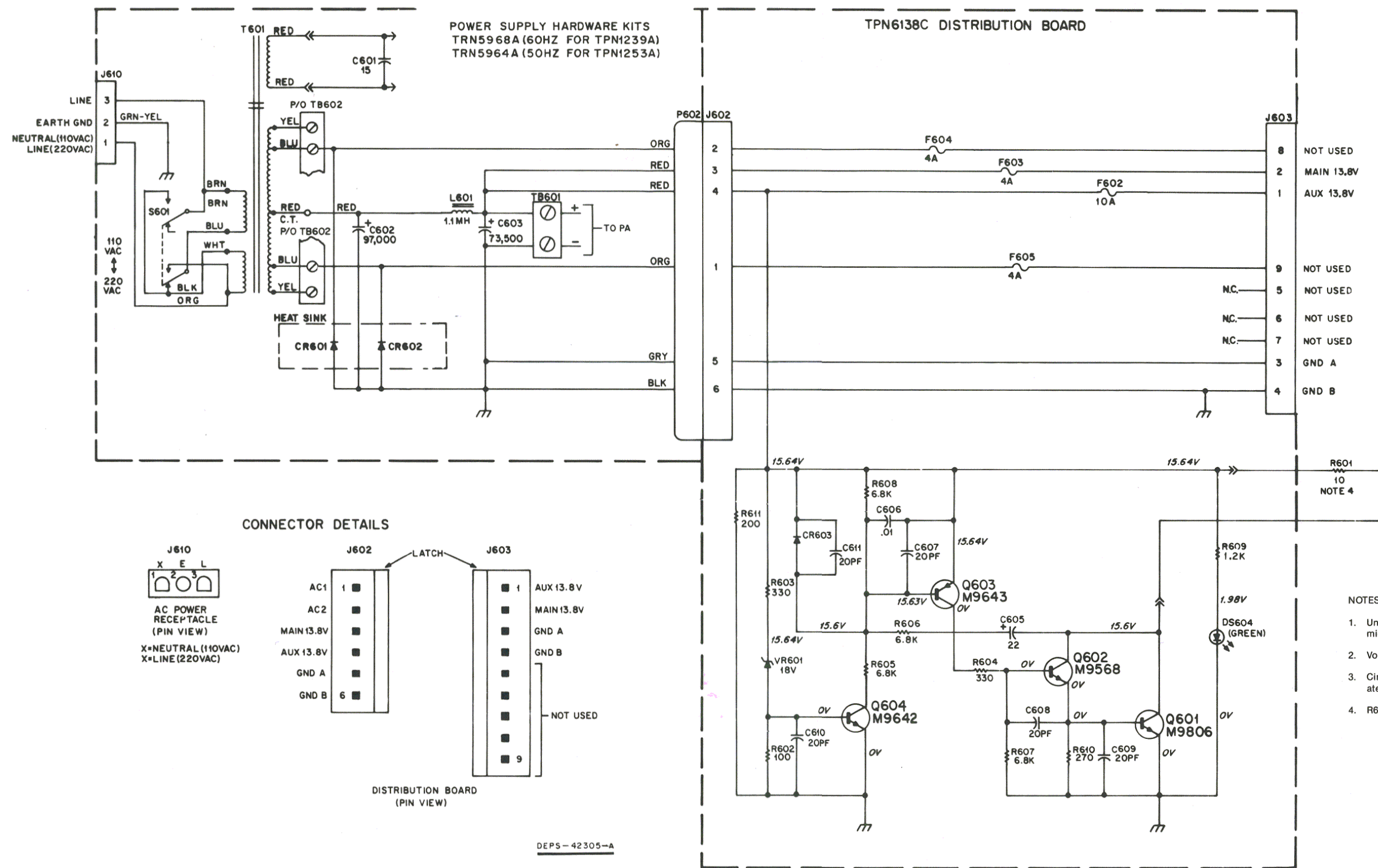
Q602 (NPN)
TOP VIEW



SHOWN FROM SOLDER SIDE

SOLDER SIDE ● BD-BEPS-46971-0
OL-CEPS-46973-0

POWER SUPPLY
SCHEMATIC DIAGRAM
MODELS TPN1239A
TPN1253A



FUSE BOX AND CABLE KITS PARTS LIST

FUSE BOX

parts list

TKN8485A Cable Fuse Box PL-9822-O		
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		Connector: assembly connector includes:
		mechanical parts
	0180799D76	AC CORD; assembly includes:
	2982607B06	lug, ring tongue
	3083211C01	cord and plug
	0180799D26	CABLE & PLUG, assembly includes:
	1583183N01	housing, plug 3-position
	2982607B06	lug, ring tongue
	3010310A19	wire #16 (brown); 11.75"
	3010310A46	wire #16 (yel); 10.31"
	3010319A77	16 ga str (blu); 12.5"
	37002505	tubing, blk vinyl 9#
	3983145N01	contact, plug; 2 used
	3983145N02	contact, plug; 2 used
	4210217A02	strap, tie

TRN9706A Fuse Box Hardware PL-9830-A		
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	0383498N04	screw, tapping; slotted star
	0383498N10	screw, tapping; 2 used
	04007569	washer, flat: 0.145 x 0.312 x .027
	0782665R01	bracket, fuseholder
	43867963	connector, crimp
	1582664R01	cover, fuseholder
	1582910N01	housing, fuse; w/mounting hardware
	37106352	grommet, rubber; 0.218 dia.
	37134165	tubing, 3/8 clear; 1.5" used
	4282018H01	retainer, cable
	4282143C02	clamp, cable
	5484119B01	label, warning

TRN9708A Power Supply Mounting Hardware PL-9511-B		
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	0284410P05	nut, speed: ¼-14"; 8 used
	03135499	screw, tapping: ¼-14 x 5/8"; 8 used
	0383498N08	screw, tapping: M6 x 1 x 10mm; 2 used
	0383677N01	screw, captive; 2 used
	0782275R01	bracket, power supply mounting left hand
	0782275R02	bracket, power supply mounting right hand
	1582733R02	cover, power supply

TRN9784A Fuse and Label (60 Hz) TRN9790A Fuse and Label (50 Hz) TRN9795A Fuse and Label (60 Hz) PL-9827-A		
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		fuse:
	6515270	6 amp; 250 V (TRN9795A)
	6552293	5 amp; 250 V (TRN9784A, TRN9790A)
	6582847N04	3.15 amp; 250 V (TRN9795A)
	6582847N05	2.5 amp; 250 V (TRN9784A, TRN9790A)
		mechanical parts
	0383498N05	screw, tapping: M4 x 0.7 x 12mm; 2 used
	3882892N01	cap, fuse (gry)
	3882892N02	cap, fuse (blk)
	4210217A10	strap, tie: 0.184 x 7.78; 2 used
	4282666R01	clip, fuseholder
	5482928P03	label, ac power; (TRN9790A)
	5482928P06	label, ac power; (TRN9795A)
	5482928P04	label, ac power; (TRN9784A)
	5484697B01	label
	5482519R02	label, warning battery (TRN9791A, TRN9795A)

CABLE KITS

TKN8472A Cable Battery (55AH) PL-9824-A		
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	29859118	lug, faston
	3083165R01	cable, 2-conductor; 65" used
	3982915N01	contact, single lug

TKN8485A Cable Fuse Box PL-9822-O		
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
F1	6582846N01	fuse: 60 amp; 300 V
		mechanical parts
	2-2878	nut, hex: ¼-20 x 7/16 x 3/16"; 2 used
	3-7297	screw, cap: ¼-20 x ½"; 2 used
	4-7670	lockwasher: ¼" internal; 2 used
	29835302	lug, ring tongue; 2 used
	30813233	wire, #10 red; 42"
	30831572	wire, #10 blk; 15.5"

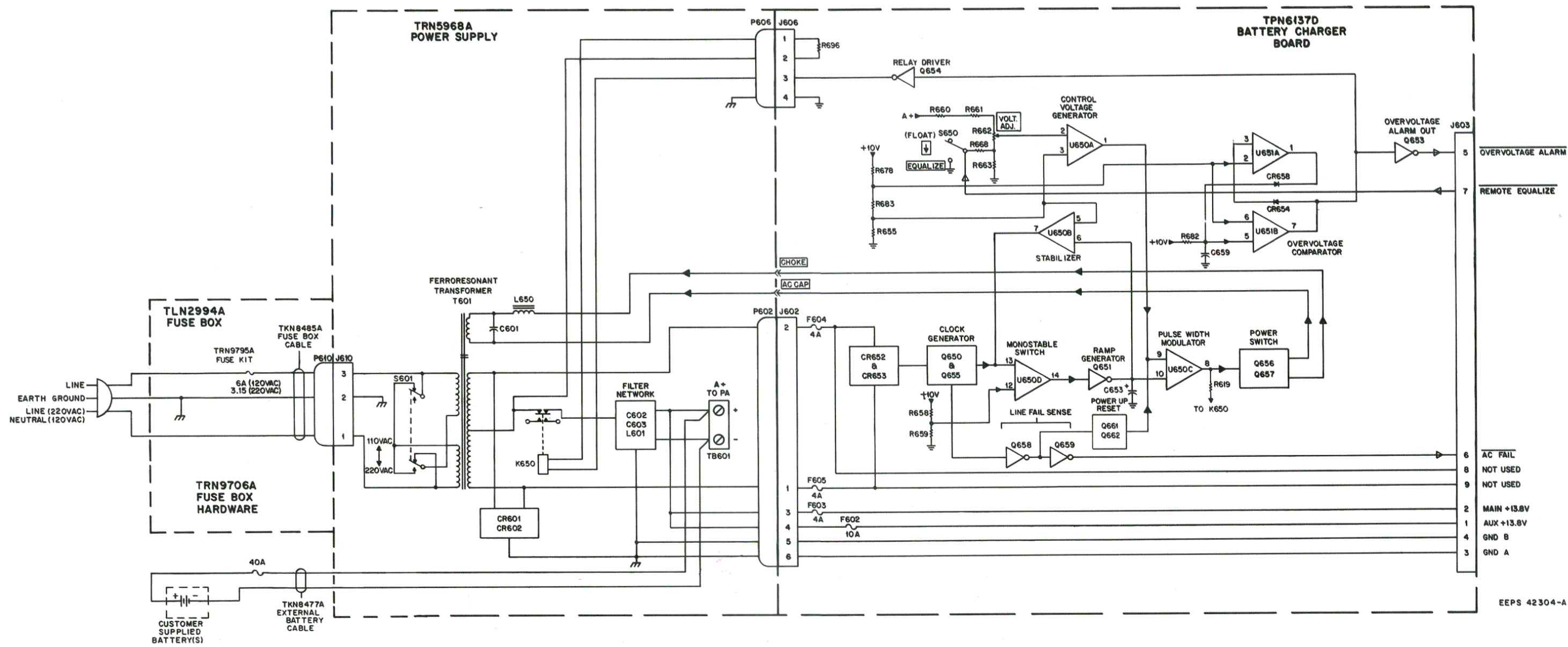
TKN8474A Cable DC Power (250 W) PL-9826-O		
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	4210217A02	strap, tie: .091 x 3.62"; 6 used
	4210217A10	strap, tie: 0.187 x 7.78"
	3010286A12	wire #16 blk, 25"
	3010286A14	wire #16 red, 25"

TKN8477A Cable 55AH Battery External PL-9823-O		
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
F1	6584161B01	fuse: 40 amp; 5AG
		mechanical parts
	2-2878	nut, hex: ¼-20 x 7/16 x 3/16"; 2 used
	3-7297	screw, cap: ¼-20 x ½"; 2 used
	4-7670	lockwasher: ¼" internal; 2 used
	9-84277B02	receptacle, fuse
	29835302	lug, ring tongue; 2 used
	4210217A02	strap, tie: .091 x 3.62"; 7 used
	30-013233	wire, #10 red, 106"
	30-831572	wire, #10 blk, 108"

BATTERY CHARGER POWER SUPPLY

MODEL TPN1254A 60 Hz, MULTI-VOLTAGE POWER SUPPLY

FUNCTIONAL BLOCK DIAGRAM



EEPS 42304-A

BATTERY CHARGER POWER SUPPLY
MODEL TPN1254A 60 Hz, MULTI-VOLTAGE POWER SUPPLY
CIRCUIT BOARD DETAIL
AND PARTS LISTS

parts list

TRN5968A Power Supply Hardware Kit (250 W) PL-9685-C

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C601	8-82682N03	capacitor, fixed: 15 uF ± 8%; 330 V
C602	23-82681N03	97,000 uF ± 75-7%; 20 V
C603	23-82681N06	73,500 uF ± 75-10%; 20 V
CR601,602	48-82732C09	diode: (see note) silicon
P602	9-83360N01	connector, receptacle: female; 6 contact
L801	25-82620P01	coil: choke; 1.1 mH
S601	40-84612B05	switch: rocker, dpdt
T601	25-83161P01	transformer: power: 250 W; 50 Hz
TB601	31-83576K02	terminal, board: 2-terminals

mechanical parts

2-10971A17	NUT, machine: M4 × 0.7 hex; 3 used
2-10971A19	NUT, M6 × 1 hex; 2 used
4-119331	LOCKWASHER, 1/4" split; 2 used
4-33423R01	WASHER, flat rectangular; 2 used
3-10908A55	SCREW, machine: M6 × 1 × 25; 4 used
3-83497N01	SCREW, machine: M4 × 0.7; 3 used
3-83497N02	SCREW, machine: M5 × 0.8 × 12 mm; 4 used
3-83498N04	SCREW, tapping: M4 × 0.7 × 7; 17 used
3-83678N02	SCREW, tapping: M3 × 0.5 × 5mm; 3 used
4-7651	LOCKWASHER, #8 internal
4-83499N01	WASHER, insulator; 2 used
4-7658	LOCKWASHER, #10 internal; 6 used
5-82904N01	GROMMET; 4 used
14-83277N01	INSULATOR, lug; 2 used
14-84088N01	INSULATOR, cap terminals; 2 used
14-84548A01	INSULATOR, washer; 2 used
15-82659P01	COVER, switch; front
15-82660P01	COVER, switch; rear
29-83005P01	HEAT SINK
27-83040P01	CHASSIS, power supply
29-82607B06	LUG, ring tongue; 3 used
29-82907N05	LUG, ring tongue; 5 used
29-83376H05	LUG, receptacle; 2 used
29-82907N05	TERMINAL, ring; YEL
29-83113N03	TERMINAL, right angle; 2 used
29-83137N01	TERMINAL, splice; 2 used
39-83146N01	CONTACT, socket
42-85238	CLAMP, cable; 2 used
42-10217A02	STRAP, tie; .081 × 3.62; 15 used
42-10217A33	STRAP, tie; .084 × 14"; 2 used
42-82903N01	CLAMP, cap; 2"
42-82903N04	CLAMP, cap; 1-3/4"; 2 used
42-82903N03	CLAMP, cap; 3"
54-82895P02	LABEL, switch
54-83971N01	LABEL
54-84046N01	LABEL
29-84709N01	TERMINAL, ring insulated (BLU)
3-83498N05	SCREW, tapping: M4 × 0.7 × 12; 2 used
3-83498N06	SCREW, tapping: M4 × 0.7 × 20
75-83056P01	PAD, snap on
2-10971A18	NUT, machine: M5 × 0.8mm; 2 used
3-10943M29	WASHER, flat: 0.281 × 0.750 × .060"; 2 used
4-135873	

TPN6137D Battery Charger Circuit Board PL-10681-D

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C649	0611051A16	capacitor, fixed: uF ± 5% 100V unless otherwise stated
C651	0611051A08	0.33 63V
C653	0611051A20	.015 63V
C654	2311019A40	.47 ± 20% 25V
C655	0682860N01	.047 ± 10% 250V
C656 thru 658	2111014A32	20pF
C659	2311019A40	47 ± 20% 25V
C660	2311019A11	2.2 ± 20% 50V
C661,662	2311019A48	220 ± 20% 10V
C663 thru 667	2111014A32	20pF
C668	2183596E20	.01 ± 20% 1000V
C669	2111014A32	20pF
C671	0611051A15	0.22 63V
C672	2111014A32	20pF
C673	2311019A46	100 ± 20% 25V
C674,675	2111014A32	20pF
C676	2311019A40	47 ± 20% 25V
C677	2384865F15	330-10 + 50% 25V

CR648 thru 648	4883654H01	diode: (see note)
CR650,651	4882466H18	silicon
CR652,653	4882466H13	silicon
CR654,655	4883654H01	silicon
CR656,657	4882466H18	silicon
CR658,659	4883654H01	silicon
CR660	4882466H18	silicon
CR661,662	4883654H01	silicon
CR668 thru 674	4883654H01	silicon

DS604	4884404E04	light emitting diode: (see note) green
-------	------------	---

F602	6500139767	fuse: 10A 32V
F603 thru 605	6582859N01	4A 32V

J602	2882984N06	connector: male; 6-contact
J603	2882984N14	male; 9-contact
J606	2883143M05	male; 4-contact

Q650	4800969649	transistor: (see note) PNP type M9649
Q651	4811056A09	NPN type M56A09
Q653	4811056A09	NPN type M56A09
Q654	4800969648	NPN type M9648
Q655	4811056A08	PNP type M56A08
Q656	4882604N01	thyristor: 4A 500V 20W
Q657	4882965F02	thyristor: 15A 800V 20W
Q658	4811056A09	NPN type M56A09
Q659	4800969628	NPN type M9528
Q661 thru 664	4811056A09	NPN type M56A09

R609	0611045A51	resistor, fixed: ± 5% 1/8W unless otherwise stated
R619	0611009A73	1.2k 1/2W
R640,641	0611009E49	10k 1/4W
R642	0611045A33	1k 1/4W
R648	0611077B15	220 1/2W
R650	0611077A81	47k
R651	0611077A88	2k
R652	0611009E60	3.9k
R653	0611045A31	3k 1/4W
R655	0604840C25	180 1/2W
R656	0611077A81	2.1k ± 0.5% 1/4W
R657	0611077A81	2k
R658	0611045A35	270 1/2W
R659	0611077B37	390k
R660	0611077B33	270k
R661	0611077A74	1k
R662	0611077A92	5.6k
R663	1884248R05	var 1k ± 20% 1/2W
R664	0611077A86	3.3k
R665	0611077A88	3.9k
R666	0611077B11	33k
R667	0611077A78	1.5k
R668	0611077B35	330k
R669	0611077B09	27k
R670	29-83113N02	47k
R671	0611077A80	1.8k
R672	0611077A74	1k
R673	0611045A59	2.7k 1/2W
R674	0611009E29	150 1/4W
R675	0611086A59	1k 1W
R676	0611077A90	4.7k
R677	0611077B15	47k
R678	0611077A80	1.8k
R679	0611009E44	620 1/4W
R680	0611045A45	680 1/2W
R681	0611077A78	1.5k
R682	0611077B21	82k
R683	0611077A80	270
R684	0611077A81	2k
R686	0611077A98	10k
R692	0611009E56	2k 1/4W

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R693	0611077A90	4.7k
R694	0611077A78	1.5k
R695	0611077A90	4.7k
R696	1782177B02	32 5W
R697	0611077A74	1k
R698	0611077B07	22k
R699	0611077B15	47k
R700	0611077B33	270k
R701	0611077B47	1 meg
R702	0611009E27	120 1/4W
R703,704	0611077B31	220k
R705	0611077B15	47k
R706	0611045A39	390 1/2W
R707	0611045A37	330 1/2W
R708	0611009E33	220 1/4W

RT650	0682768A08	thermistor: 2.02k @ 25 degrees C
-------	------------	-------------------------------------

S650	4083204B02	switch: dpdt slide
------	------------	-----------------------

U650	5183222M39	integrated circuit: (see note) quad operational amplifier
U651	5183222M56	dual operational amplifier

VR650	4882256C56	voltage regulator: Zener: 8.8V
VR651	4882256C25	Zener: 12V
VR654,655	4883461E36	Zener: 6.2V
VR674	4882256C56	Zener: 8.8V
VR675	4882256C58	Zener: 39V

non-referenced items

0210971A16	NUT, machine: M3 × 0.5; for Q657
0383497N04	SCREW, machine: M3 × 0.5 × 8; for Q657
0400007883	WASHER, #4 internal lock; for Q657
1483820M02	INSULATOR, heat conductive; for Q657
1584576N02	SHROUD, fuse terminal; for F602-605
2884275L01	HEAT SINK; for Q657
2910251A10	TERMINAL, mounting; 3 used
2882966N01	TERMINAL, fuse; 8 used

note: For optimum performance, diodes, transistors, and integrated circuits must be ordered by Motorola part numbers.

TRN5965A Battery Charger Hardware Kit PL-9625-B

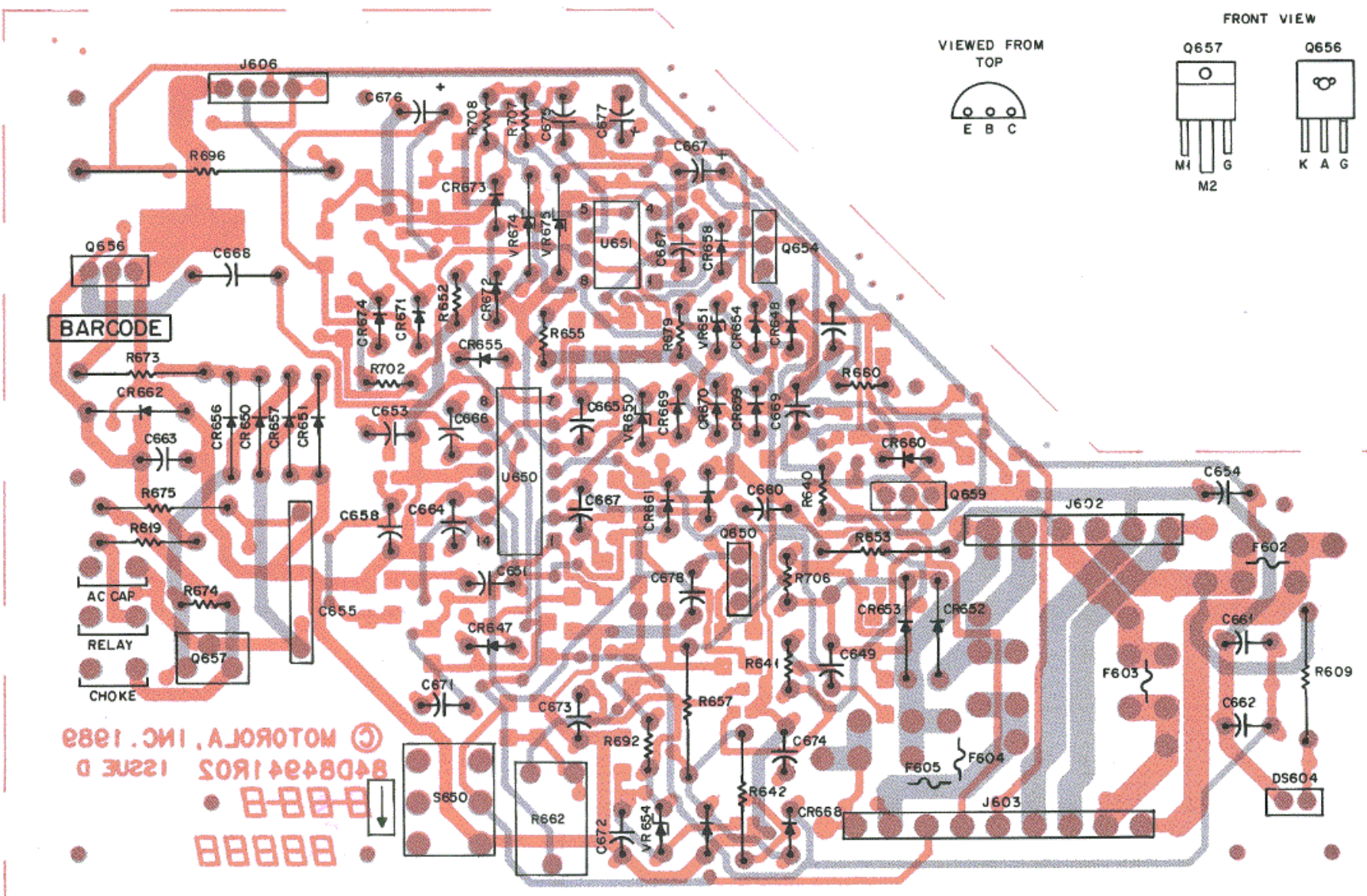
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
K650	80-82623P01	relay: 1 form 2; coil res. 100 ohm; 12 V
L650	25-82419N02	coil, rf: choke: 80 mH; 60 Hz (TRN5965A)
	25-82419N03	choke: 120 mH; 50 Hz (TRN5961A)
P606	15-83142M08	connector: consists of: HOUSING, 4 position
	39-82717M01	CONTACT, receptacles; 4 used

mechanical parts

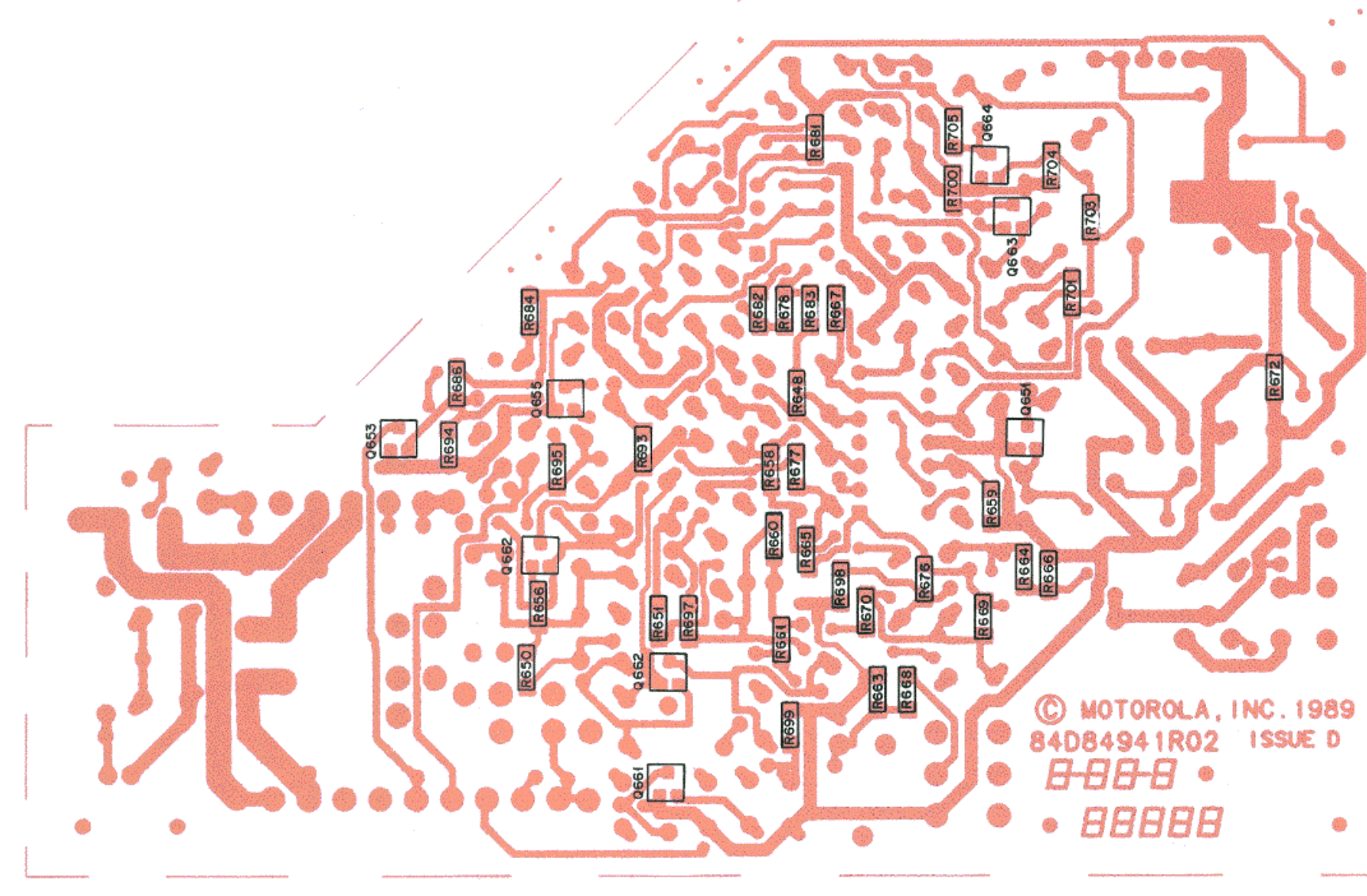
2-121841	NUT, hex: 6-32 × 5/16 × 7/64"
2-10971A17	NUT, machine: M4 × 0.7mm
2-10971A18	NUT, machine: M5 × 0.8mm
3-10843M29	SCREW, tapping: TT5 × 0.8 × 13mm
3-83497N03	SCREW, machine: M5 × 0.8 × 23mm; 4 used
3-83497N05	SCREW, machine: M4 × 0.7 × 10mm
3-83498N04	SCREW, tapping: M4 × 0.7 × 7mm; 8 used
4-7651	LOCKWASHER: #8 internal
4-7658	LOCKWASHER: #10 internal
5-82904N02	GROMMET; 4 used
7-83004P01	BRACKET, relay
7-83006P01	BRACKET, battery charger
14-83986N01	INSULATOR
15-83901N01	COVER
29-82907N05	TERMINAL, ring yel
29-83113N02	TERMINAL, right angle; 7 used
29-83376H05	LUG, receptacle; 4 used
30-813233	WIRE, battery; 3.5"
42-10217A02	TIE WRAP, .001 × 3.62"; 7 used
43-82980N01	STAND-OFF; 6 used
54-83971N01	LABEL

note: For optimum performance, diodes, transistors, and integrated circuits must be ordered by Motorola part numbers.

TPN6137D BATTERY CHARGER BOARD



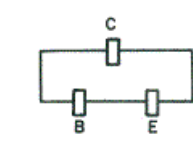
SHOWN FROM COMPONENT SIDE



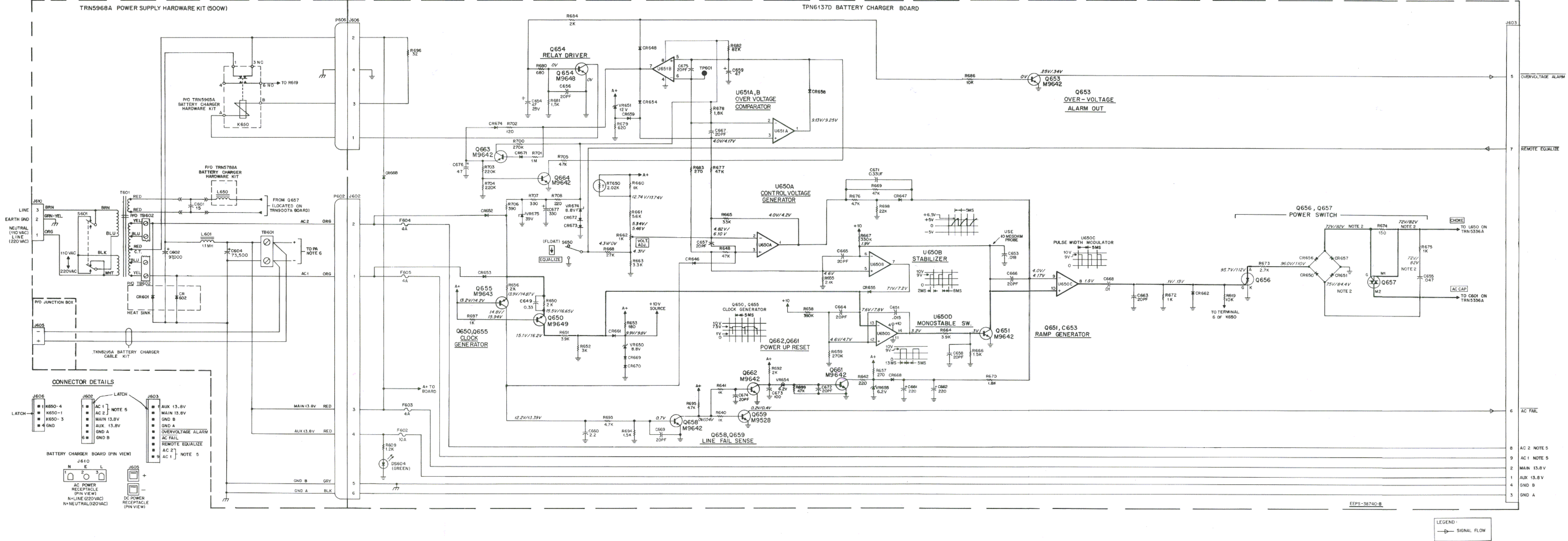
SHOWN FROM SOLDER SIDE

CHIP TRANSISTOR
DETAILS

VIEWED FROM TOP



BATTERY CHARGER POWER SUPPLY
MODEL TPN1254A 60 Hz, MULTI-VOLTAGE POWER SUPPLY
SCHEMATIC DIAGRAM



- NOTES:
1. Unless specified otherwise, all capacitor values are in microfarads and resistor values in ohms.
 2. Waveform is non-sinusoidal. Voltage in recorded rms.
 3. Voltages measured with DVM, with 1 megohm or greater input impedance.
 4. Voltages measured correspond to SW650 = float position/normalize position, 120 V ac line, 2A load current, with output voltage set to 13.2 V in the float position by R622. Voltage measured @ TB601.
 5. Used in MSR 2000 stations only.
 6. The + and - wires from TB601 connect to TB801 on MSR 2000 stations and directly to the power amplifier on MSF 5000 stations.

Integrated Circuit Data Chart

Reference Designation	VCC/VDD Pin No.	Gnd Pin No.	Description
U650	8	4	Quad Operational Amplifier
U651	8	4	Dual Operational Amplifier

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1. INTRODUCTION

1.1 The *Digitac* comparator is designed to adapt to a wide variety of system applications, and therefore can be connected in a system in several different ways. This guide illustrates several typical system types with suggested connections. A short description is included with each system diagram describing what that particular configuration might be used for while also showing the connections required. Only one remote receiver connection is shown and the reader is allowed to expand this number as required.

1.2 The comparator can be purchased with or without the transmit control option (C175AG-SP). The transmit control option adds two circuit boards to the basic setup. Without the transmit control option, the comparator is used primarily as a receiver concentrator for use in dispatch systems. When the transmit control option is added, the comparator can be used in voting repeater applications with console operation prioritized by the comparator.

1.3 All diagrams with transmit control option C175AG-SP use tone remote control. Users wishing to optimize system access time may wish to use a dc logic signal to indicate console PTT and control transmit PTT. These signals are available and ready for use. The user need only shut off high level guard tone and function tones to achieve this operation. This permutation is not shown on any diagram.

1.4 Users using multiple function tones (i.e. positive mode control or frequency control) need to modify several parameters. The first is to set the number of function tones to decode to 2. A common symptom of missing this parameter is that the comparator operates "ok" in repeat mode, but fails to key the station in console dispatch mode. The other parameter that needs to be changed is the second function tone used in clear and coded transmissions.

1.5 Following the system diagrams is a listing of parameters that need to be modified for operation. Both the receive portion and the transmit portion are listed. The parameter lists are handled in the way they differ from default, therefore the user only has to modify the parameters mentioned. Within the appendix are complete lists of parameters in the comparator and their usage.

1.6 There are only two types of connections between the comparator and the system it operates in: modem and non-modem (the term modem refers to the telephone line Digital Voice Modem). Non-modem are lines connected via hard copper, microwave links, RF radio links, etc. As far as the comparator is concerned, if any receiver is linked via modem, all connections are considered modem.

1.7 For the transmit portion, the comparator ships from the factory with the conventional coded configuration as the default. All other configurations need to be selected by the user. Finally, a list of jumpering setups are included. Again, all jumpering is described in terms of how the jumpering should change. In the section of this document describing jumper locations is a table describing standard jumpering (as shipped from the factory). In addition, a block diagram is included describing the effects of the jumpering. Pin connections for the comparator are provided. The user should feel free to learn more about the comparator in these sections and create any system desired.

2. SERIAL PORT (RS-232 CONNECTION)

2.1 The serial port found on a *Digitac* kernel board and on the transmit controller can be configured for interface to a wide variety of devices (printing terminal, phone line modem, 'dumb' terminal, personal computer etc.) using the RS-232 standard. The port is wired as data terminal equipment (DTE), so any device which is also wired as DCE requires a 'straight through' cable for interface to the *Digitac*. Any device wired as DTE requires a 'null modem' cable (or a straight through cable with a null modem adaptor) for interface to the *Digitac*. The term 'null modem' refers to an adaptor which interchanges the transmit and receive lines (and other lines depending on hardware configuration) in order to allow two DTE's or two DCE's to communicate with each other (RS-232 is designed for the connection of DTE to DCE).

2.2 Once the cable is plugged in, a simple test would be to reset the *Digitac* (using the switch labeled TEST) and check for the appearance of characters printed on the CRT screen/printer. The following example is what the startup message on the transmit controller side looks like.

SECURENET DIGITAC COMPARATOR
TRANSMIT SOFTWARE VERSION 1.50 0
COPYRIGHT MOTOROLA INC. 1988
ALL RIGHTS RESERVED

Performing self-tests

All chip level tests passed
Loopback testing completed.
Self-test complete

If characters appear, the cable is good and no further adjustments need be made. If characters appear but are unreadable, one of two problems may exist. Try typing a few characters on the device. If they still do not appear, the baud rate may need adjustment (on either the device or the *Digitac*). If the typed characters are displayed properly when typed, but the startup message does not appear properly after reset, the inter-character delay may need adjustment. (Note: The *Digitac* is configured for the following: 8 bit word, 1 stop bit and no parity.)

2.3 The baud rate used for the diagnostic port is selected via a dip switch found on the *Digitac* backplane interconnect board. Note that on a chassis containing a transmitter controller option, the dip switch setting affects both kernel boards. See the *Digitac* manual (1S-SP5253351) Installation and Troubleshooting section (3.6.4.3 page 10) for dip switch settings. The default settings are 9600 baud and 4 milliseconds inter-character delay. The baud rate can be set to 300, 1200, 2400, or 9600 baud.

2.4 Additional character delay is needed when an external device cannot process characters as quickly as the *Digitac* sends them. This is readily apparent when the *Digitac's* startup message is not fully readable. A delay between characters can be introduced by the *Digitac* via commands issued from the terminal. See section 7.7 in NOVRAM parameter description under either the Receive or Transmit parameters for additional serial i/o settings. Note that all settings must be made on both the kernel board and the transmit controller in the chassis containing the transmitter controller option.

3. ADJUSTING THE PERSONALITY

3.1 To change the personality settings it is necessary to enter the service mode. This is easily done with the "S" command. (The comparator is case insensitive.) When the S command is used, the response should be as shown below. The service mode does not support any of the processes that perform the voting tasks during the normal mode of operation. As a result, the service mode should only be entered when it is acceptable to interrupt normal service. The software guards against accidental service mode entry by querying with a short message. A response other than "Y" or "y" does not result in entry into the service mode.

```
S
Do you wish to enter service mode? (y/n) --> y
Now in service mode. Type H or ? for help.
```

3.2 Once the service mode is entered a short prompt message is printed out to indicate that the service mode is active and the TEST LED on the kernel board begins to flash rapidly. In the service mode there are multiple levels for the commands, and the initial level is at the top. To display the top level commands simply type H or ? and the following message will appear when accessed on the transmit controller.

```
?
Service mode commands are:
H or ? help
P Personality Editing
Set line Levels:
C Set Up Audio Paths From Console Inputs to LINE OUT
R Set Up Audio paths From Receiver Inputs to LINE OUT
G Generate Tone on LINE OUT

Q quit service mode
```

3.3 To change the personality settings and parameters simply type P which enters a lower level for commands specialized to personality editing. These commands may be displayed (as shown below) by typing the H or ? command.

```
P
Now editing the personality.
H
Personality editing commands are:
A Edit High Level Guard Tone Parameters
B Edit Console Receive Audio Parameters
C Edit Control Tone Sequences
D Edit Date
E Exit Personality Editing
F Fetch Defaults
G Edit General Parameters
H or ? Help
I Edit Serial I/O
K Edit Coded Parameters
L Edit Low Level Guard Tone Parameters
M Edit Memo
N Edit Function Tone Parameters
P Print Current Settings
Q Quit Service Mode
R Read From Nonvolatile Storage
S Edit Configuration
T test Novram
U Edit Keyup Keydown Timing
V Edit Valid Tone List
W Write to Nonvolatile Storage
X Set Transmitter Interconnect
Z Edit Failsoft Parameters
```

3.4 The comparator's personality settings are stored in a special memory device called a NOVRAM. The NOVRAM is designed so that it can retain its memory contents even after power is shut off. It has a significant limitation in that the non-volatile storage can only be written into relatively slowly and only for a finite number of times. Fortunately the write operation can be performed many thousands of times which is more than enough if the writes are carefully controlled. Because of this limitation, the software does not write to the NOVRAM unless the user tells it to. The command to do this is the 'W' command.

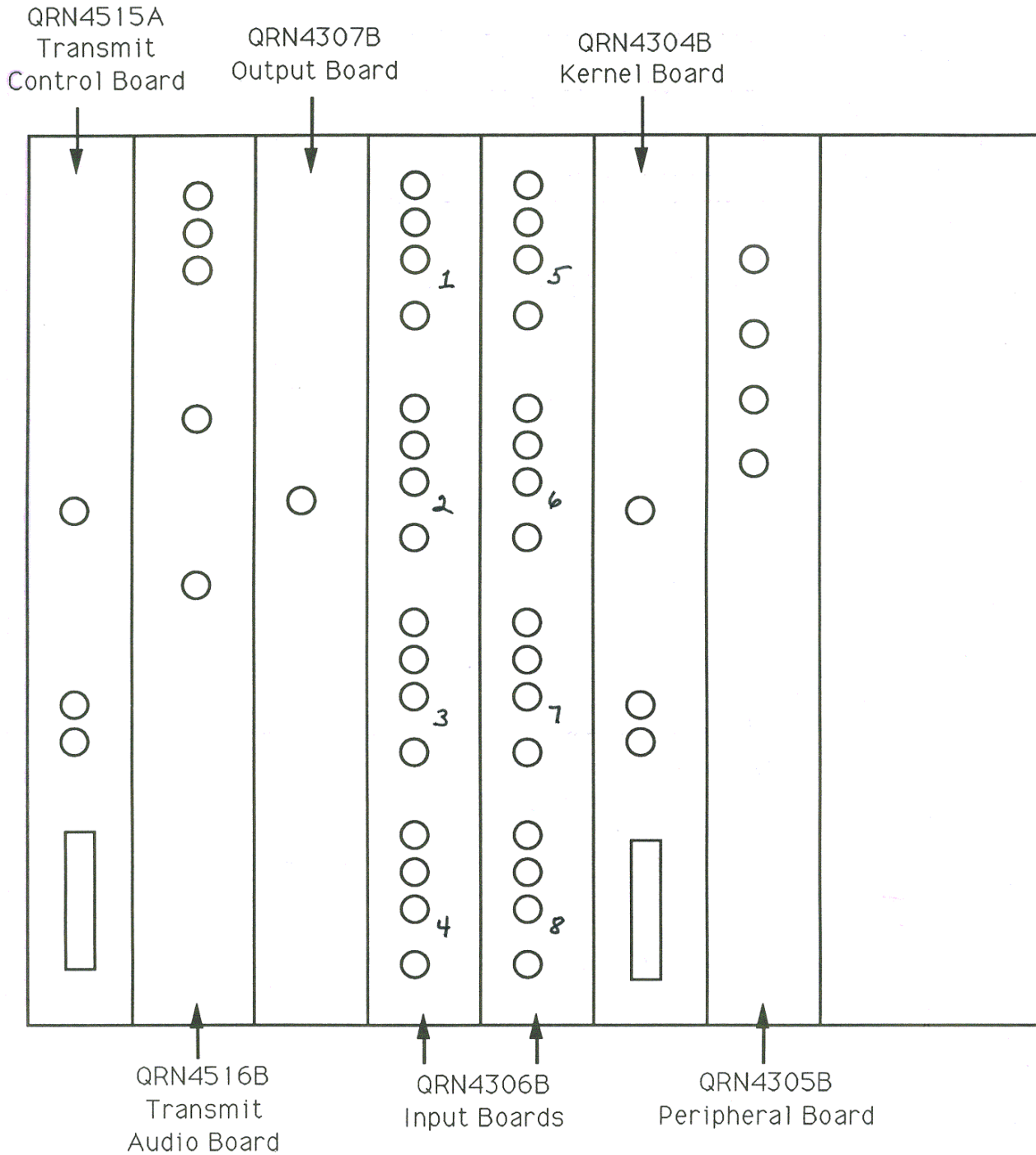
3.5 To change the personality, a separate copy is stored in the regular memory. This storage is volatile so any power interruptions while the editing process is underway will destroy the memory - but not the NOVRAM data. The contents of the copy may be initialized to the factory defaults with the "F" command. The copy can also be copied from the NOVRAM itself with the "R" command. When service mode is first entered, the copy is whatever was created by the power-up diagnostics; either the factory defaults or the NOVRAM contents.

3.6 To edit any of the personality settings, simply enter the appropriate command. In general, the comparator steps through each of the values in the category one by one. For each value it first prints out the current value. The user is then allowed to type any value that is desired. Once the user types a <return>, the comparator processes the value and either accepts, modifies, or rejects the value. In any case the software then prints out the new value (which may be same as the old value if there is no change). If the user makes a mistake, or types an unexpected or illegal character, then the comparator rejects the input and makes no change to the current value.

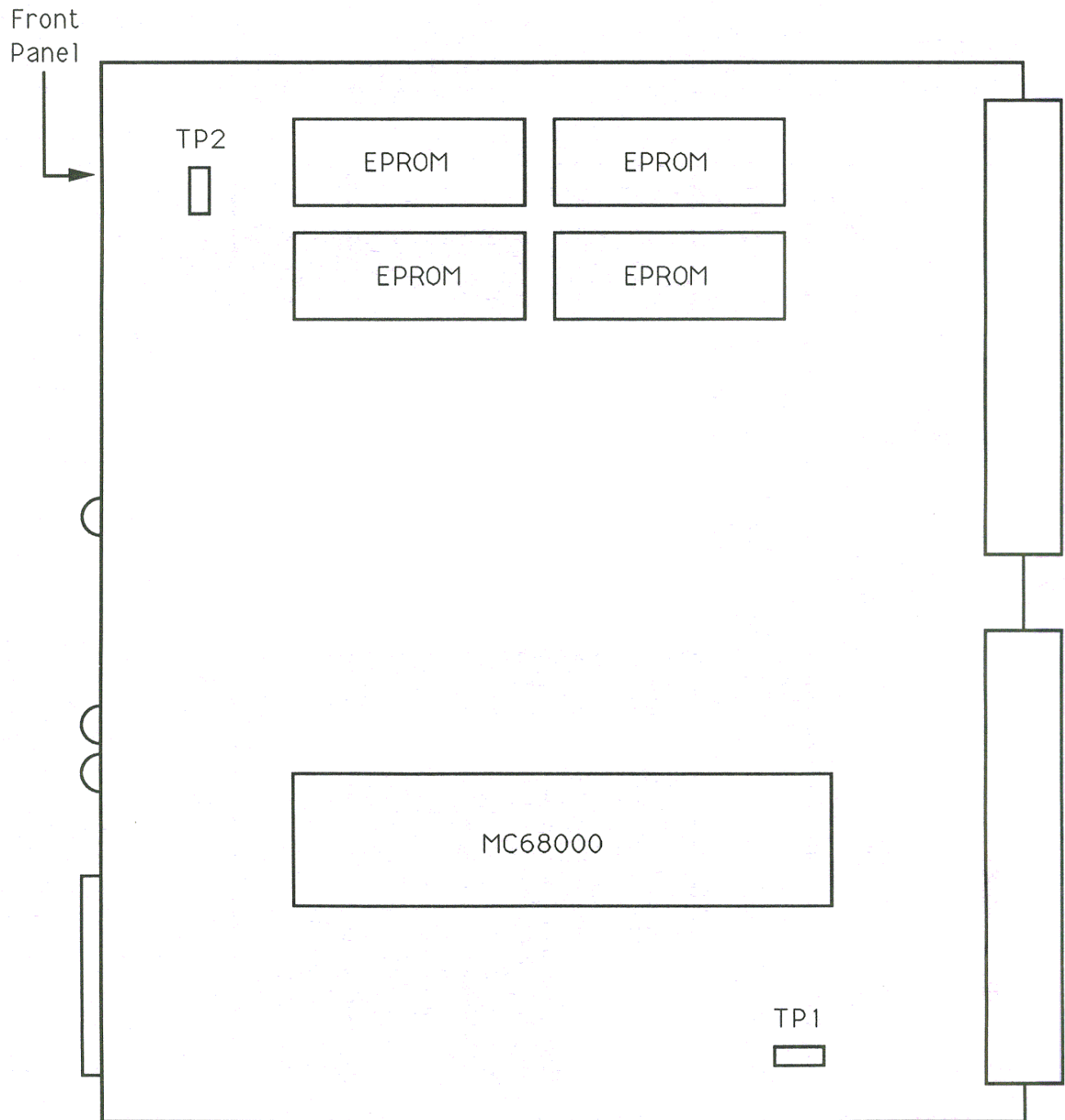
3.7 Finally, the user should issue the "W" command to write the new values to the NOVRAM and then enter the "Q" command to exit the edit mode and return to normal operation.

4. BOARD/JUMPER LOCATIONS

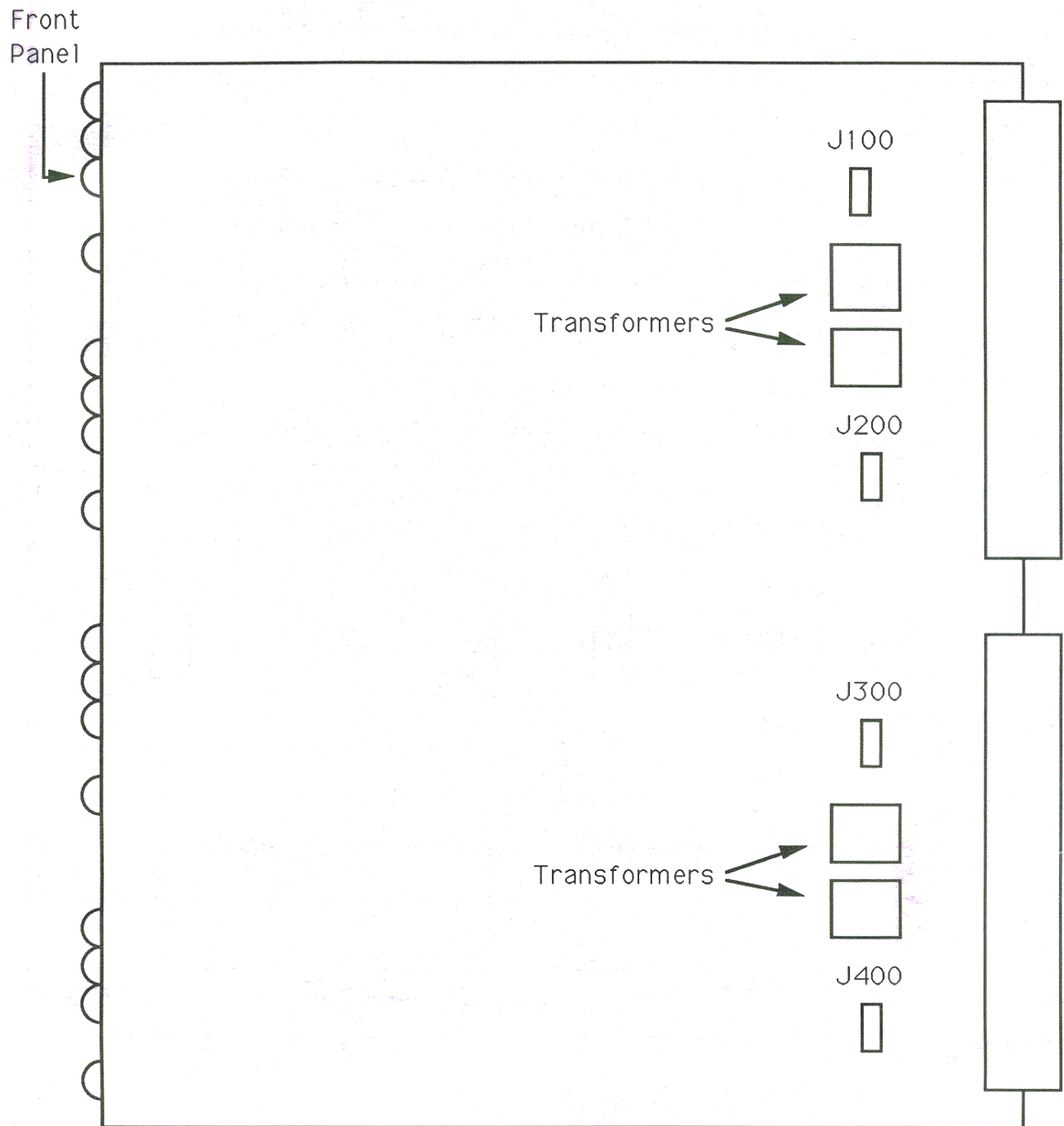
4.1 DIGITAC CHASSIS



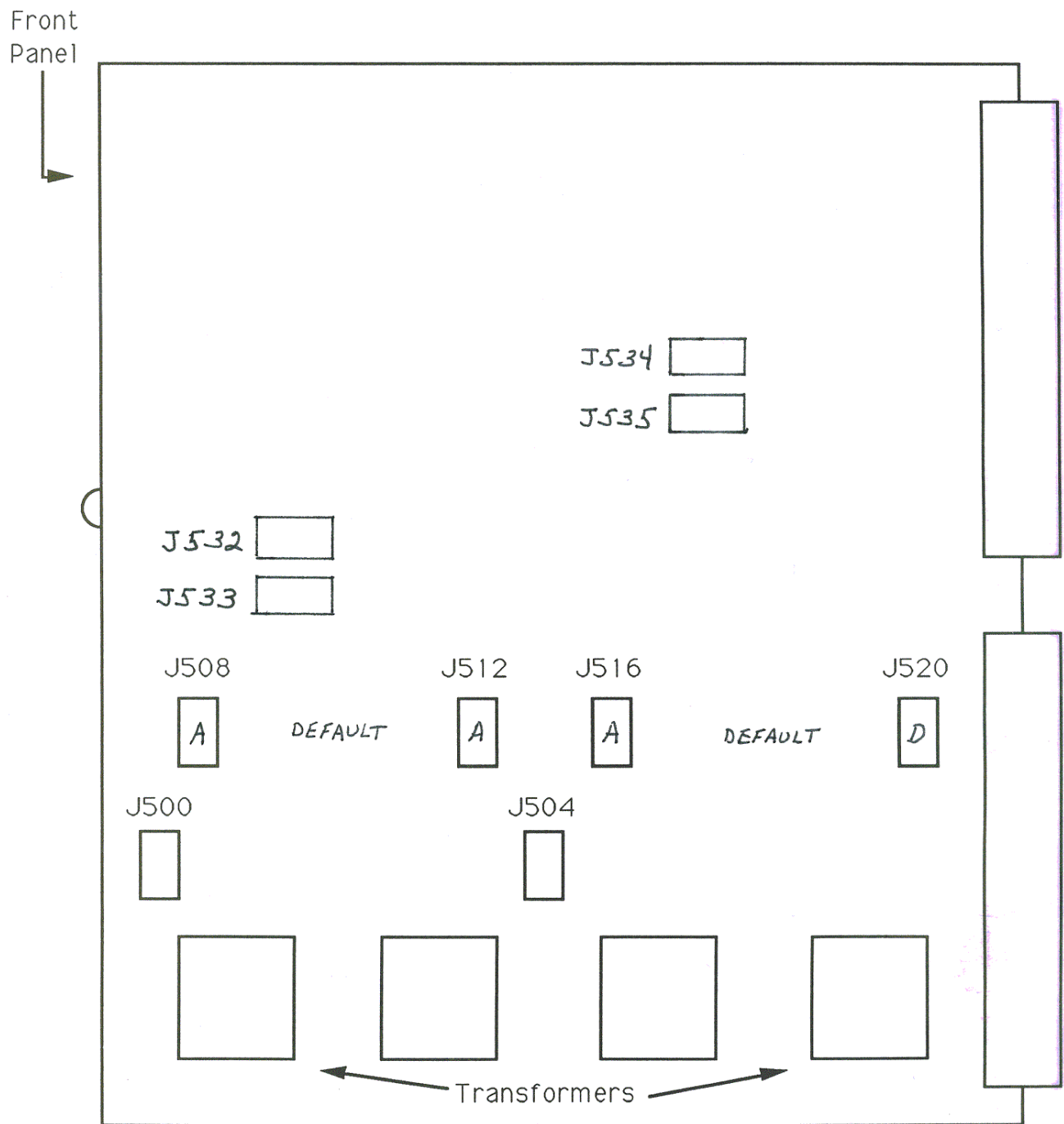
4.2 JUMPER LOCATIONS FOR RECEIVE KERNEL BOARD (QRN4304B) AND TRANSMIT CONTROL BOARD (QRN4515A)



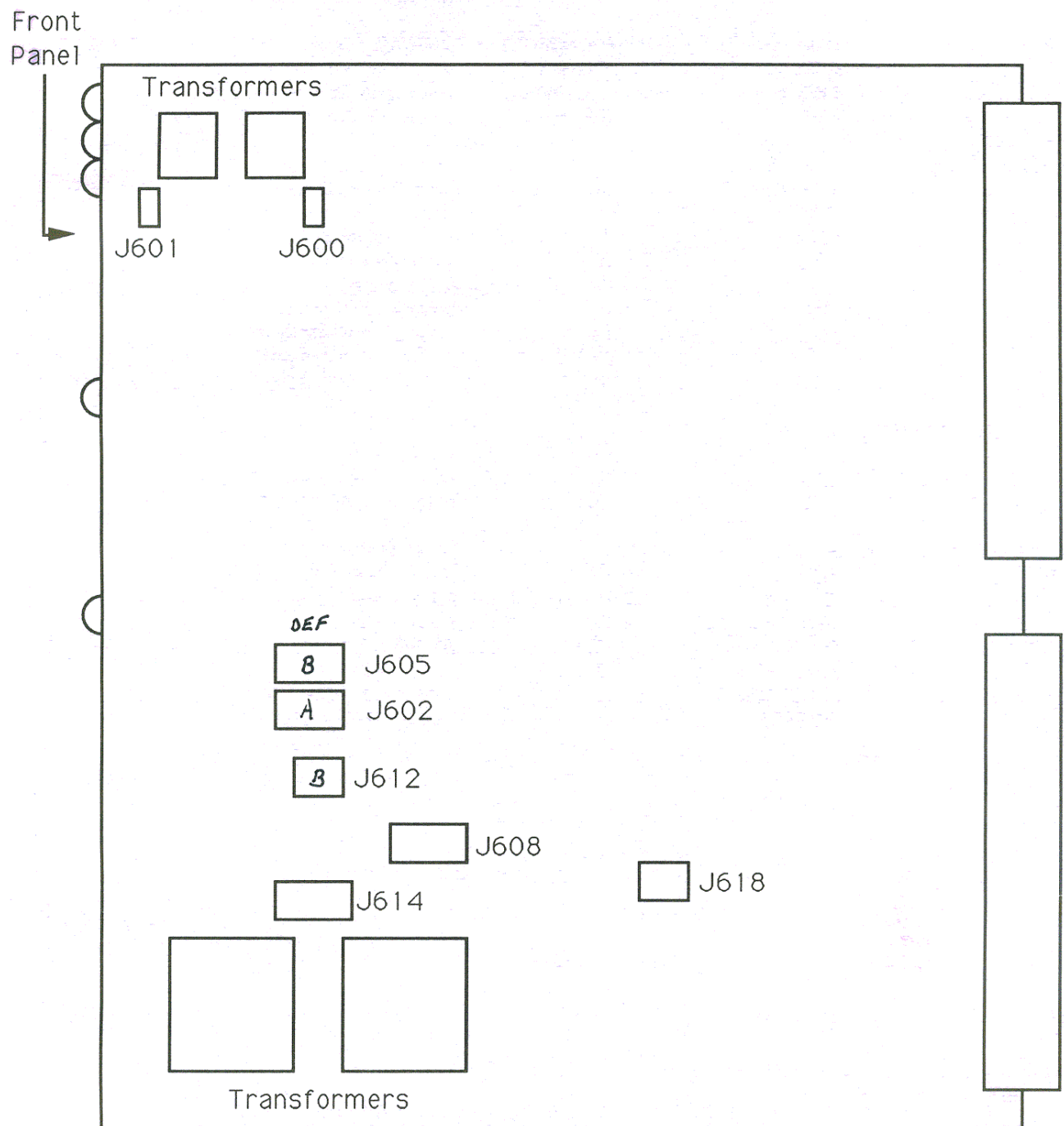
4.3 JUMPER LOCATIONS FOR RECEIVE INPUT BOARD (QRN4306B)



4.4 JUMPER LOCATIONS FOR RECEIVE OUTPUT BOARD (QRN4307B)



4.5 JUMPER LOCATIONS FOR TRANSMIT AUDIO BOARD (QRN4516B)



4.6 STANDARD *DIGITAC* JUMPERING SCHEME

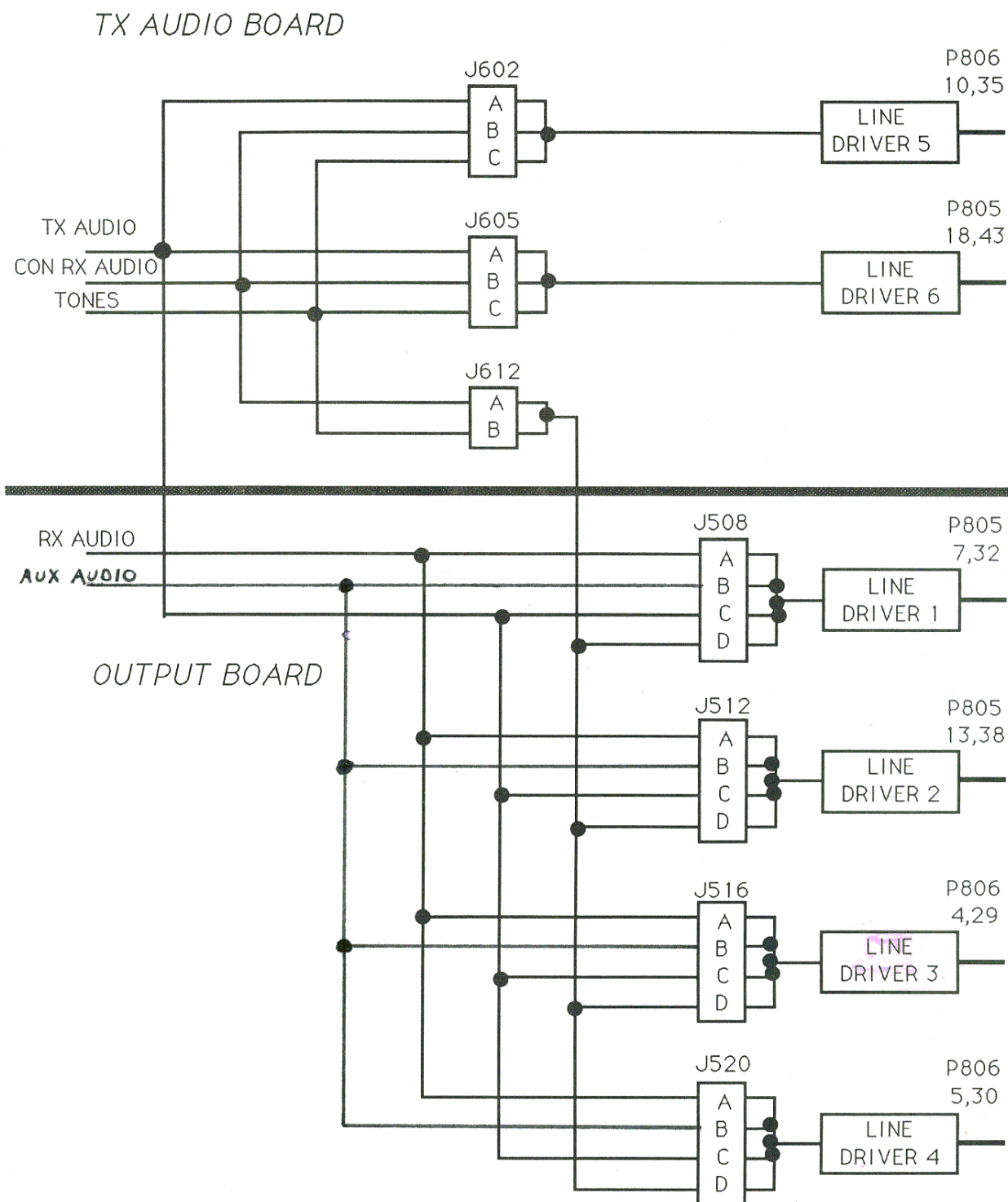
4.6.1 Receive Module

	<u>Jumper</u>	<u>Position</u>	<u>Function</u>
• Kernel Board	TP1, TP2	Out	Watchdog Enabled, Service Mode Enabled
• Input Board	J100	Position 2-3	Level Selector
	J200	Position 2-3	Level Selector
	J300	Position 2-3	Level Selector
	J400	Position 2-3	Level Selector
• Output Board	J500A thru D	In	Line Driver Jumper
	J504A thru D	In	Line Driver Jumper
	J508	A	Audio Selector
	J512	A	Audio Selector
	J516	A	Audio Selector
	J520	D	Audio Selector
	J532	In	Coded Level Jumpers
	J533	In	Coded Level Jumpers
	J534	In	Coded Level Jumpers
	J535	In	Coded Level Jumpers

4.6.2 Transmit Module

• Control Board	TP1, TP2	Out	Watchdog Enabled, Service Mode Enabled
• Transmit Audio Board	J500A thru D	In	Line Driver Jumper
	J504A thru D	In	Line Driver Jumper
	J508	A	Audio Selector
	J512	A	Audio Selector
	J516	A	Audio Selector
	J520	D	Audio Selector
	J532	In	Coded Level Jumpers
	J533	In	Coded Level Jumpers
	J534	In	Coded Level Jumpers
	J535	In	Coded Level Jumpers

4.7 LINE DRIVER BLOCK DIAGRAM



5. SYSTEMS WITHOUT TRANSMITTER CONTROL OPTION (C175AG-SP)

5.1 CONVENTIONAL CODED CONFIGURATION

The conventional coded configuration is used when the *Digitac* is not configured with a transmit controller and transmit audio board (no connection to a transmitter). A 2-wire interface exists between the *Digitac* and both the console and satellite receivers. An optional MDC decoder is shown. The RX hold time is set equal to the MDC time so the vote will not switch during MDC signaling. The comparator is not capable of providing muting on the console receive path in this configuration.

Parameters Used:

RX:

Default Parameters
Hold Time

700ms (for MDC)

Jumpering Used:

Standard Configuration

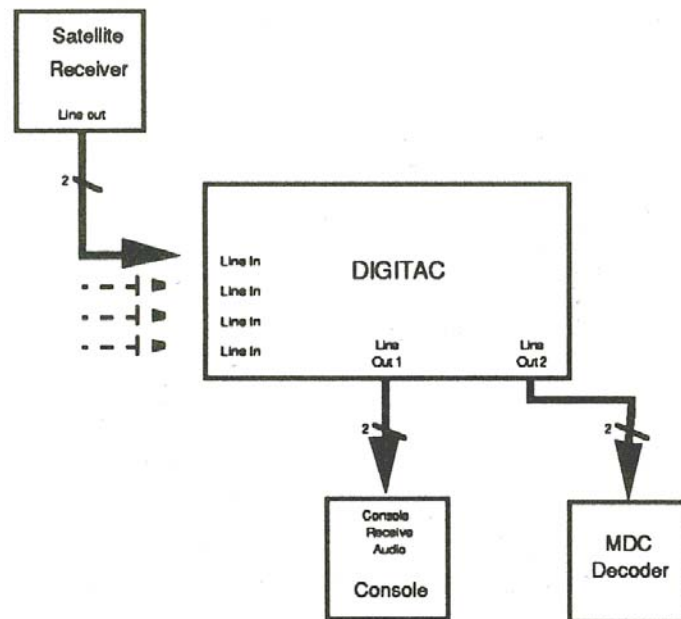


Figure 1. Conventional Coded Configuration Without TX Control Option

5.2 CONVENTIONAL CLEAR CONFIGURATION

The conventional clear configuration is used when the *Digitac* is not configured with a transmit controller and transmit audio board (no connection to a transmitter). A 2-wire interface exists between the *Digitac* and both the console and the satellite receivers. An optional MDC decoder is shown. The RX hold time is set equal to the MDC time so the vote will not switch during MDC signaling. The comparator is not capable of providing muting on the console receive path in this configuration.

Parameters Used:

RX:

Default Parameters
Clear Audio Mute Time
Hold Time

0ms
700ms (for MDC)

Jumpering Used:

Standard Configuration

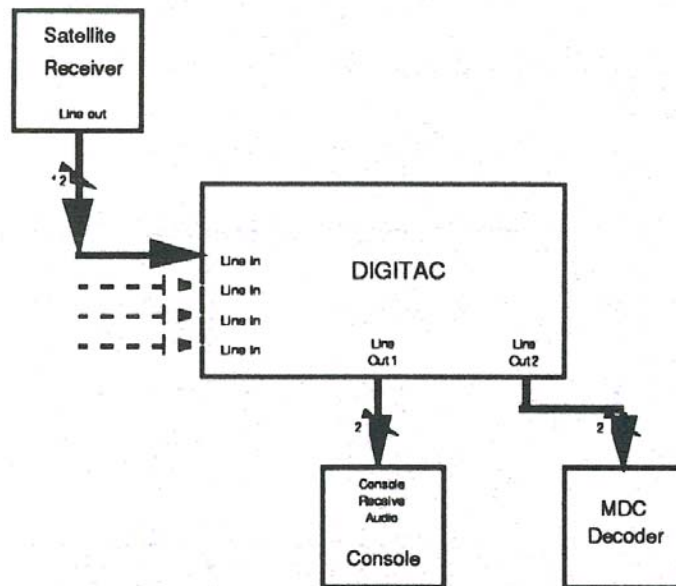


Figure 2. Conventional Clear Configuration Without TX Control Option

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6. SYSTEMS WITH TRANSMITTER CONTROL OPTION (C175AG-SP)

6.1 CONVENTIONAL CODED

6.1.1 Standard Configuration

This configuration is used when the *Digitac* is remotely located from the console, base station and satellite receivers. A 6-wire interface is used between the *Digitac* and both the base station and console.

Parameters Used:

RX:

Default Parameters

TX:

Conventional Coded Configuration

Jumpering Used:

Standard Configuration

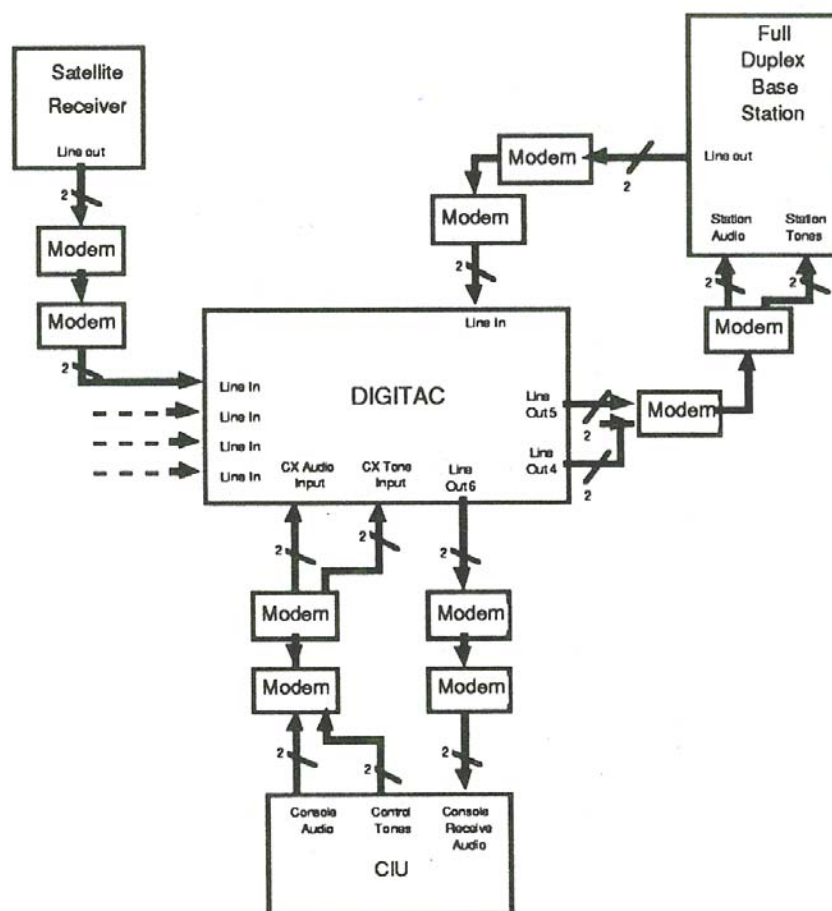


Figure 3. Standard Configuration

6.1.2 Non-Modem Connected Base Station

This configuration is used when the *Digitac* is non-modem connected to the base station site (the console and satellite receiver are both remotely located). Since the comparator is transparent and can be located with the station, it is preferable to co-locate the station and comparator to reduce modem costs. In addition, the collocation improves immunity to phone line faults.

Parameters Used:

RX:

Default Parameters

TX:

Conventional Coded Configuration

Jumpering Used:

Standard Configuration

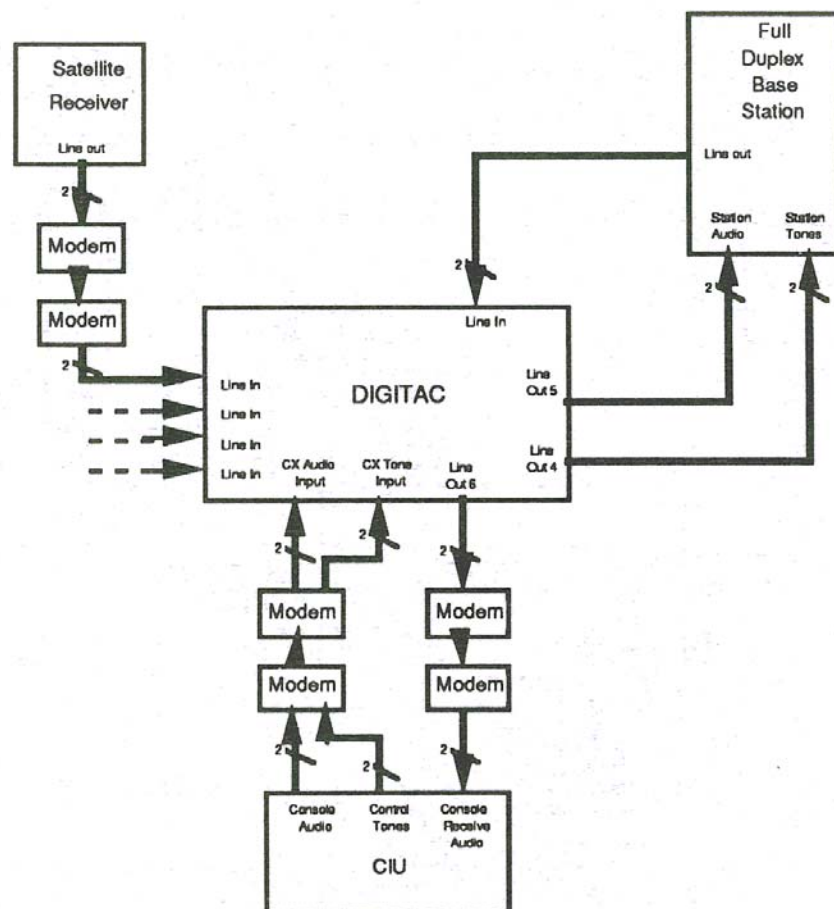


Figure 4. Non-Modem Connected Base Station

6.1.3 Non-Modem Connected Console

This configuration is used when the *Digitac* is non-modem connected to the console site, (the base station and satellite receiver are both remotely located).

Parameters Used:

RX:

Default Parameters

TX:

Conventional Coded Configuration

Jumpering Used:

Standard Configuration

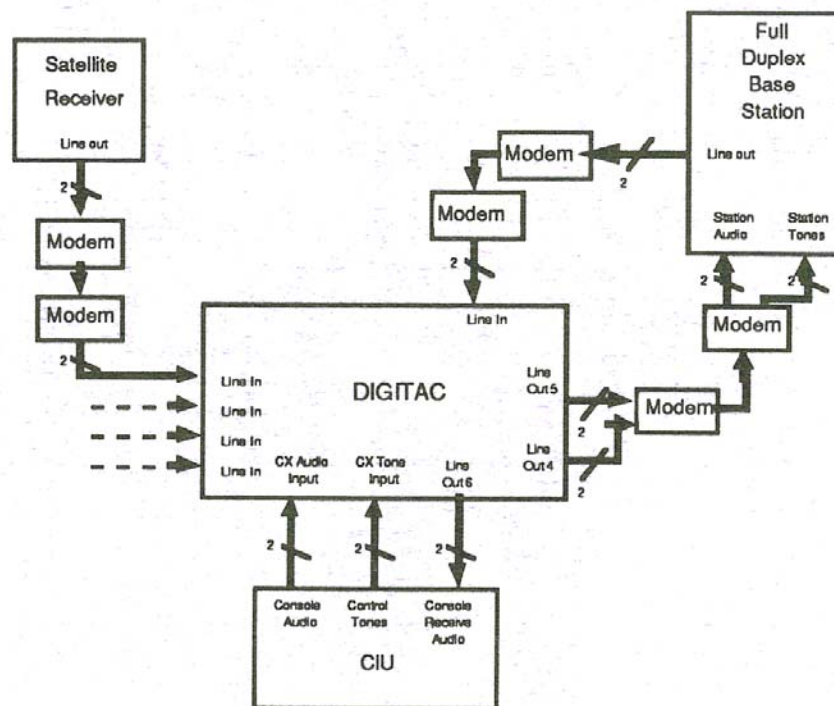


Figure 5. Non-Modem Connected Console

6.1.4 Non-Modem Connected Satellite Receiver

This configuration is used when the *Digitac* is non-modem connected to the satellite receiver sites and the base station, (the console is remotely located).

Parameters Used:

RX:

Clear Audio Mute Time 50ms

Differential Input Delay 30ms

TX:

Conventional Coded Configuration

Jumpering Used:

Standard Configuration

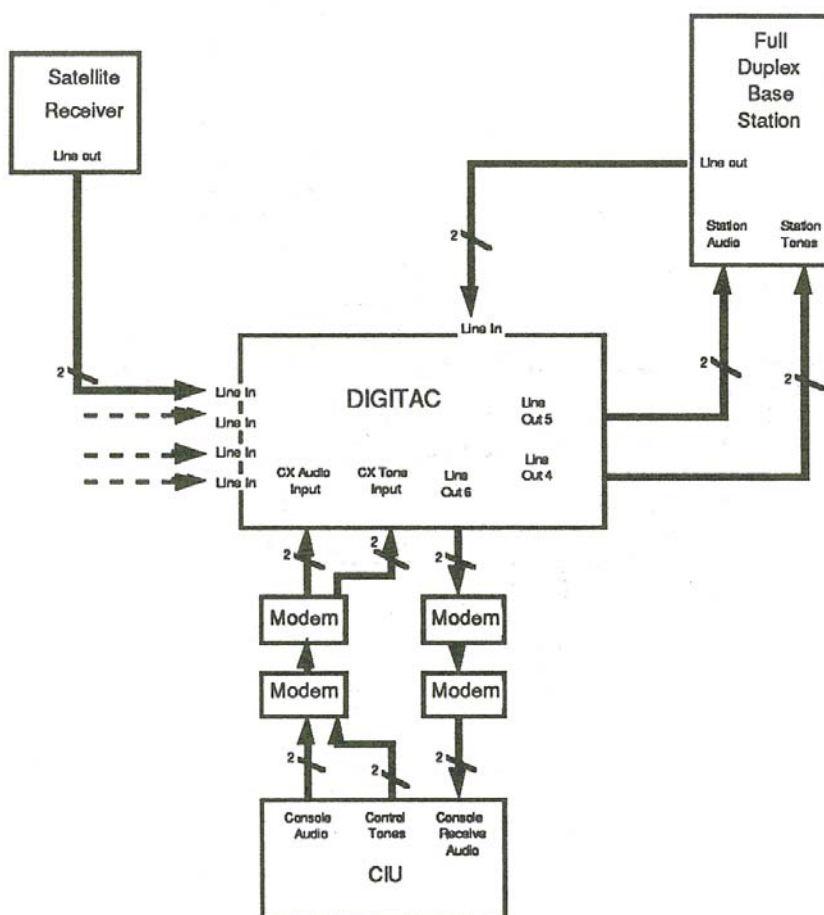


Figure 6. Non-Modem Connected Satellite Receiver

6.1.5 All Non-Modem Connected

This configuration is used when the *Digitac*, base station, satellite receiver and the console are all non-modem connected. This configuration is typical of systems utilizing a microwave backbone.

Parameters Used:

RX:

Clear Audio Mute Time 50ms

Differential Input Delay 30ms

TX:

Conventional Coded Configuration

Jumpering Used:

Standard Configuration

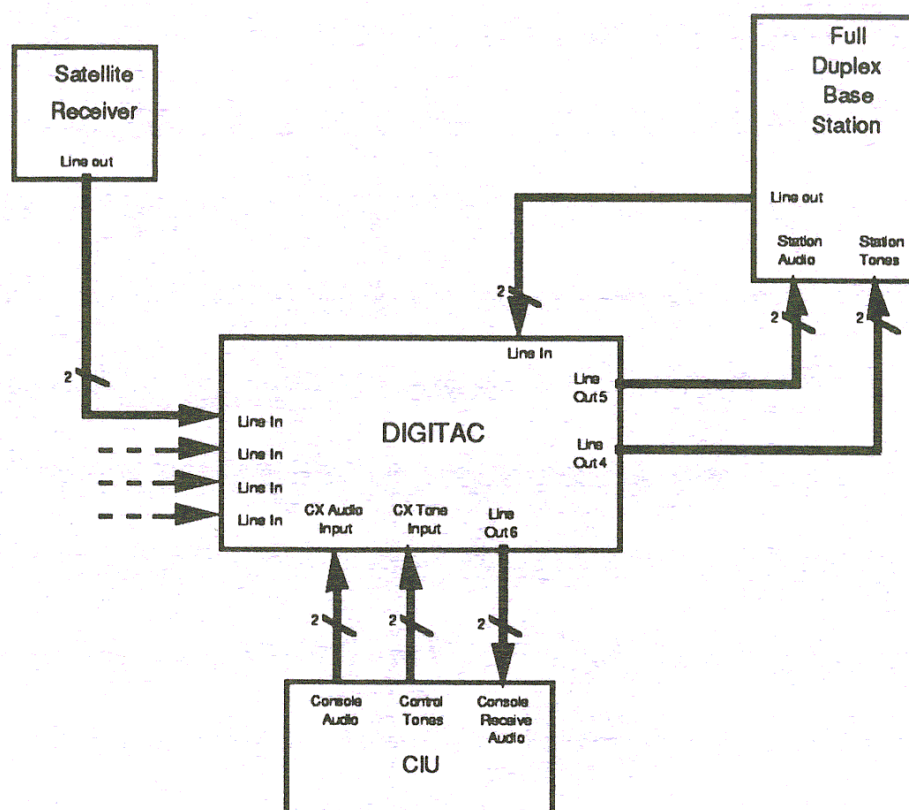


Figure 7. All Non-Modem Connected

6.1.6 4-Wire Interface to Base Station

This configuration is used when there is a 4-wire interface to the base station. The interface to the CIU remains 6-wire.

Parameters Used:

RX:

Default Parameters

TX:

Conventional Coded Configuration

Tones out on Transmit Audio Line

Y

Transmit Audio Notch Filter

Y

Jumpering Used:

Standard Configuration

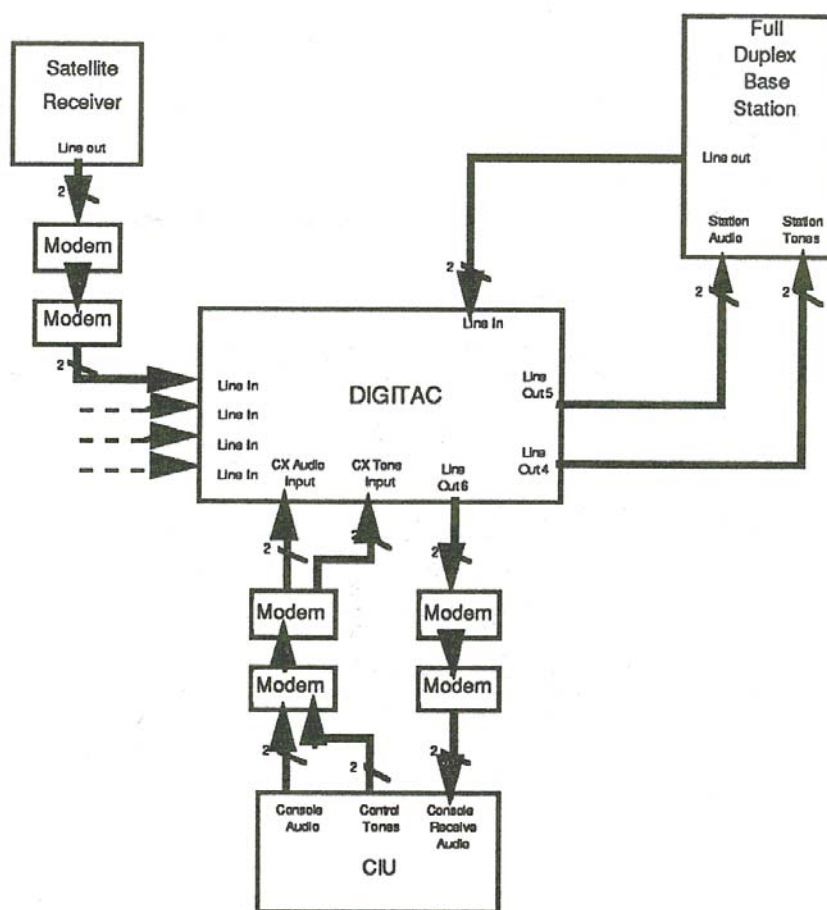


Figure 8. 4-Wire Interface to base Station

6.1.7 4-Wire Interface to Console

This configuration is used when there is a 4-wire interface to the console. The interface to the base station remains 6-wire.

Parameters Used:

RX:

Default Parameters

TX:

Conventional Coded Configuration

Tones in on Console Audio Line

Y

Jumpering Used:

Standard Configuration

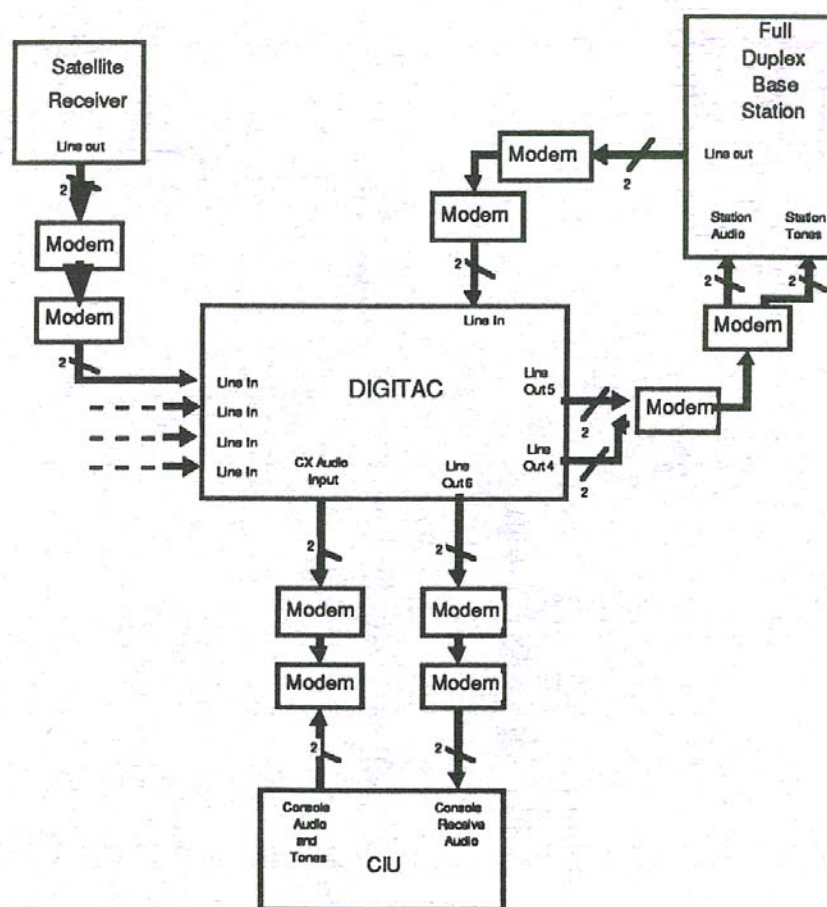


Figure 9. 4-Wire Interface to Console

6.1.8 4-Wire Interface to Console and base Station

This configuration is used when there is a 4-wire interface to both the console and base station. Typically, when a system engineer decides to implement 4-wire audio, all lines will be configured this way.

Parameters Used:

RX:

Default Parameters

TX:

Conventional Coded Configuration

Tones out on Transmit Audio Line

Y

Transmit Audio Notch Filter

Y

Tones in on Console Audio Line

Y

Jumpering Used:

Standard Configuration

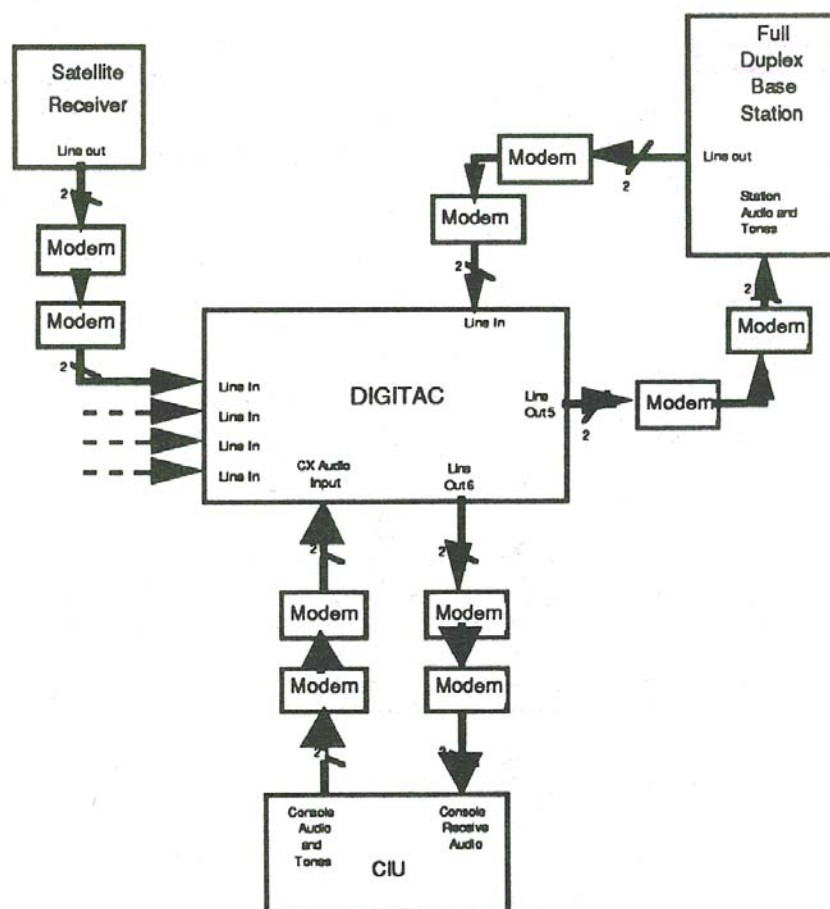


Figure 10. 4-Wire Interface to Console and Base Station

6.1.9 MDC Signaling

This configuration is used when MDC 600™ (or MDC 1200™) is used on the radio system. The mute time used should be approximately 150 milliseconds more than the MDC signaling time for the mute to work correctly.

Parameters Used:

RX:

Clear Audio Mute Time	0ms
Hold Time	750ms

TX:

Conventional Coded Configuration	
Console Receive Audio Mute Time	900ms
Repeat Clear Delay	900ms

Jumpering Used:

Standard Configuration

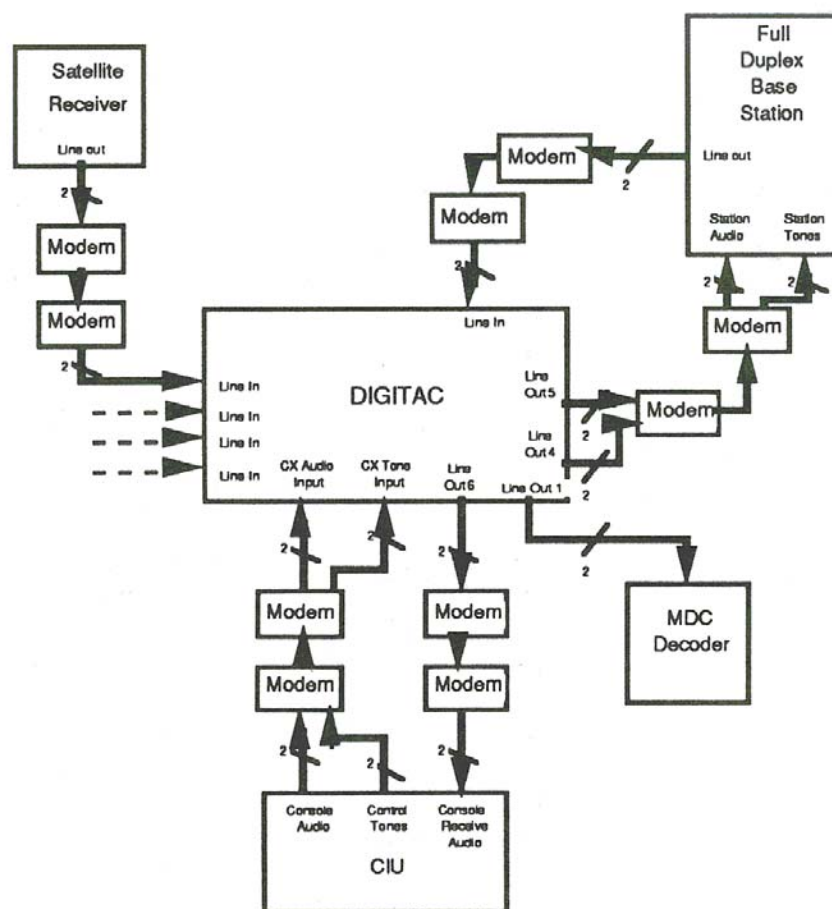


Figure 11. MDC Signaling Configuration

6.1.10 4-Wire Interface to Console and Base Station with MDC Signaling

This configuration is used when MDC 600 (or MDC 1200) is used on the radio system. There is also a 4-wire interface to the console and base station. The mute time used should be approximately 150 milliseconds more than the MDC signaling time for the mute to work correctly.

Parameters Used:

RX:	Clear Audio Mute Time	0ms
	Hold Time	750ms
TX:	Conventional Coded Configuration	
	Tones out on Transmit Audio Line	Y
	Transmit Audio Notch Filter	Y
	Tones in on Console Audio Line	Y
	Console Receive Audio Mute Time	900ms
	Repeat Clear Delay	900ms

Jumpering Used:

Standard Configuration

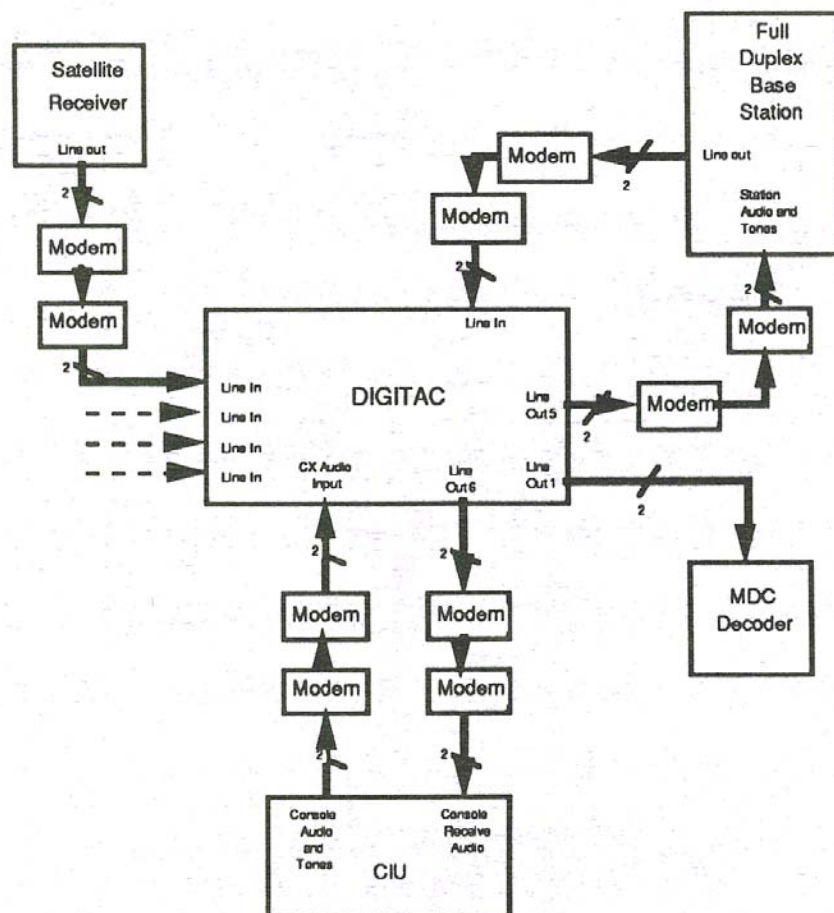


Figure 12. 4-Wire Interface to Console and Base Station with MDC Signaling

6.1.11 Multiple Consoles and 4-Wire Interface to Base Station

This configuration is used when there are two consoles connected to the *Digitac* input. There are 4-wire interfaces between the *Digitac* and both consoles and the station. This configuration only provides limited multiple console operation. Also, only one console may use tone remote control because the *Digitac* can only decode tones on one console. The second console must use a logic PTT line to signal activity.

Parameters Used:

RX:

Default Parameters

TX:

Conventional Coded Configuration

Tones out on Transmit Audio Line Y

Transmit Audio Notch Filter Y

Tones in on Console Audio Line Y

Transmit Audio to Console Y

Jumpering Used:

Standard Configuration

Output Board J512 Position D

Transmit Audio Board J612 Position A

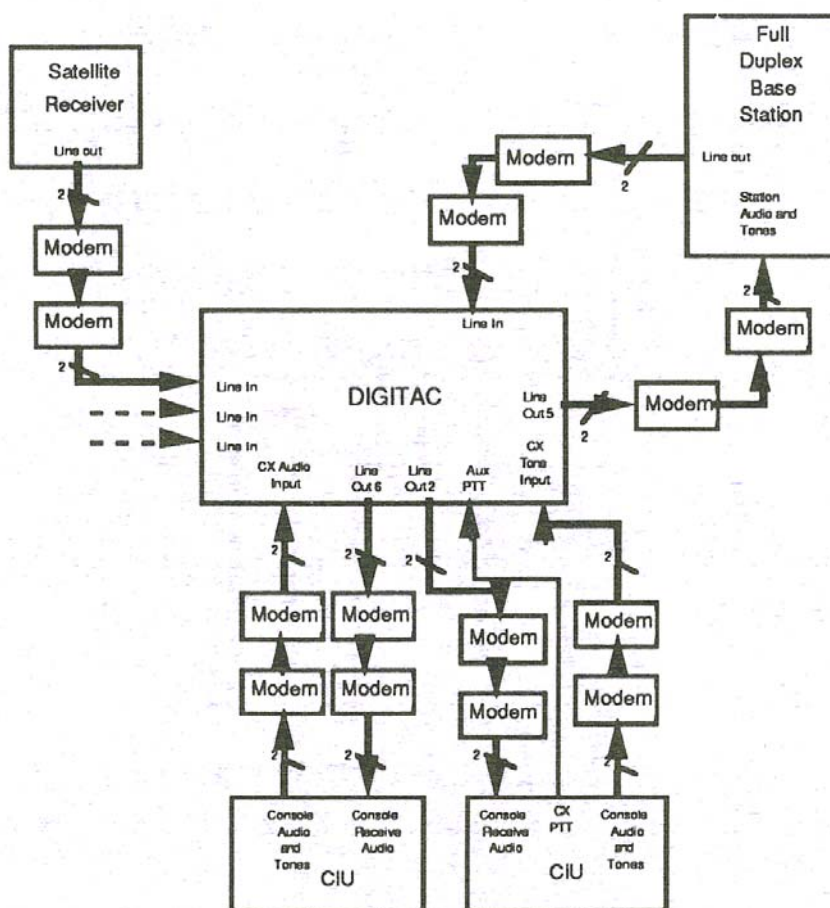


Figure 13. Multiple Console and 4-Wire Interface to Base Station

6.1.12 Clear Only Phone Patch and 6-Wire Interface to Base Station

This configuration is used when (instead of multiple consoles), a clear only phone interconnect is wired directly to the *Digitac*. There is also a 6-wire interface to the base station.

Parameters Used:

RX:

Default Parameters

TX:

Conventional Coded Configuration

Tones in on Console Audio Line

Transmit Audio to Console

Jumpering Used:

Standard Configuration

Transmit Audio Board J612 Position A

Transmit Audio Board J605 Position C

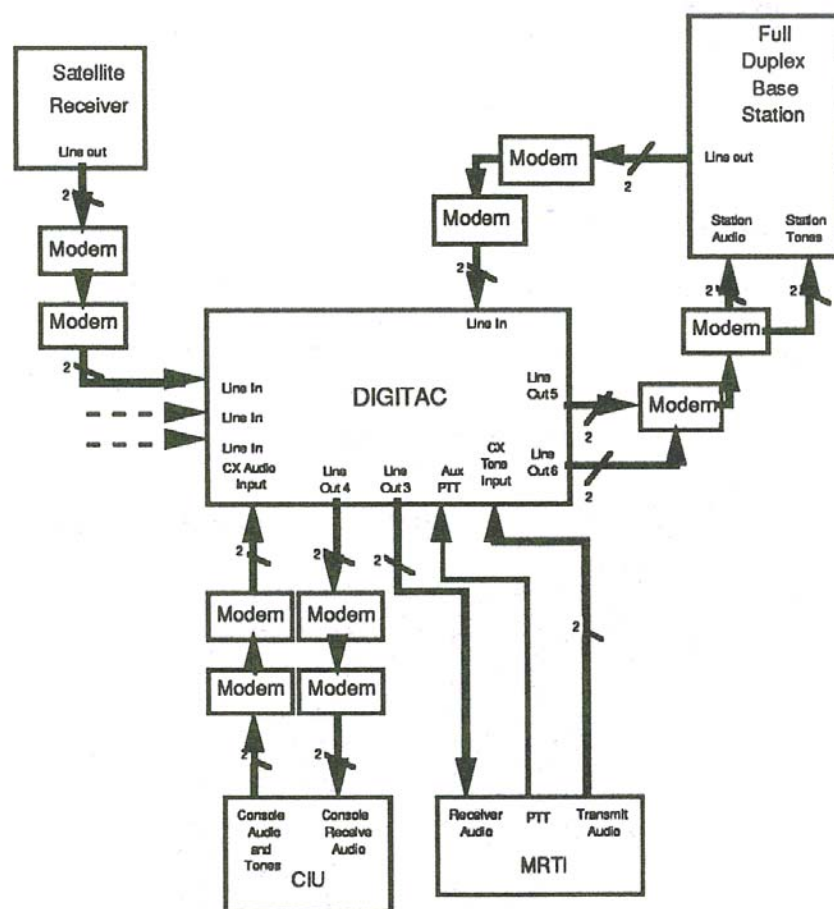


Figure 14. Clear Only Phone Patch and 6-Wire Interface to Base Station

6.1.13 Clear Only Phone Patch and 4-Wire Interface to Base Station

This configuration is used when (instead of multiple consoles), a clear only phone interconnect is wired directly to the *Digitac*. There is also a 4-wire interface to the base station.

Parameters Used:

RX:

Default Parameters

TX:

Conventional Coded Configuration

Tones out on Transmit Audio Line

Y

Transmit Audio Notch Filter

Y

Tones in on Console Audio Line

Y

Transmit Audio to Console

Y

Jumpering Used:

Standard Configuration

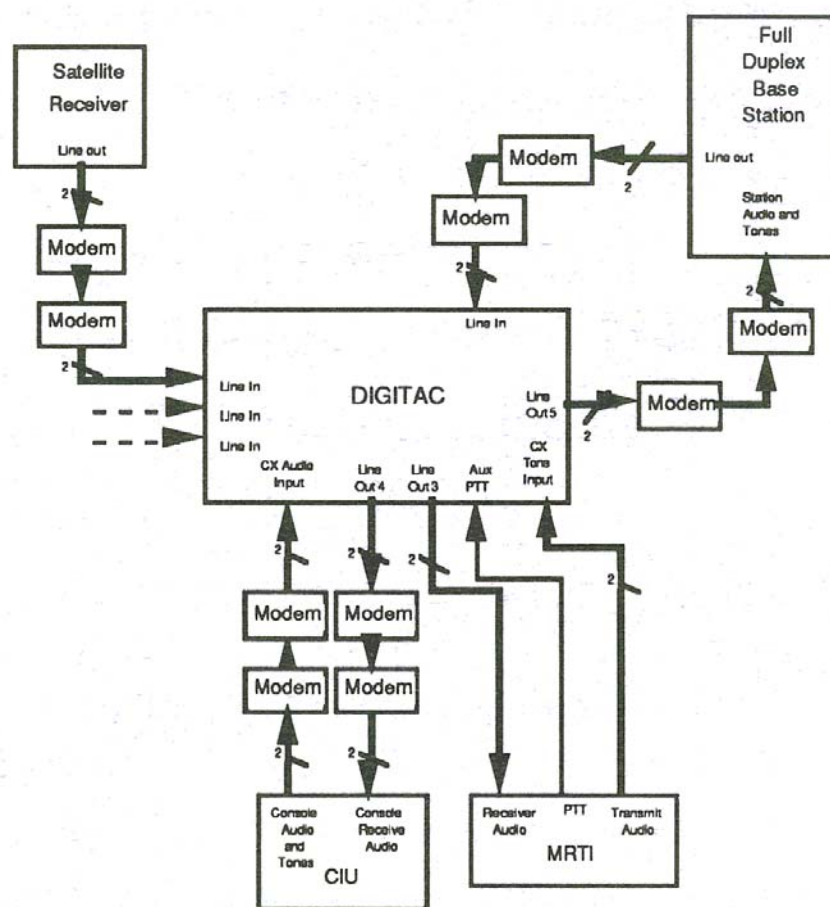


Figure 15. Clear Only Phone Patch and 4-Wire Interface to Base Station

6.2 CONVENTIONAL CLEAR

6.2.1 Standard Configuration

This is the default configuration for the Conventional Clear Configuration. There is a 4-wire interface between *Digitac* and both the base station and console.

Parameters Used:

RX:
Clear Audio Mute Time 0ms

TX:
Conventional Clear Configuration

Jumpering Used:

Standard Configuration

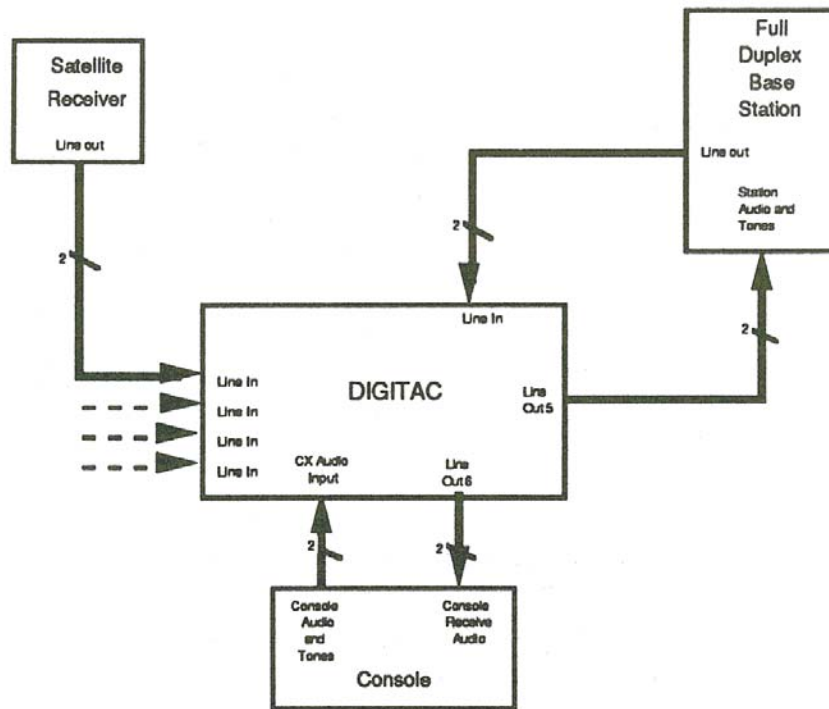


Figure 16. Standard Configuration

6.2.2 MDC Signaling

This configuration is used when MDC signaling is used in a conventional clear configuration. There is a 4-wire interface between *Digitac* and both the base station and console. There is a 2-wire connection to the MDC decoder.

Parameters Used:

RX:

Clear Audio Mute Time	0ms
Hold Time	750ms

TX:

Conventional Clear Configuration	
Repeat Clear Delay	750ms
Console Receive Mute Time	750ms

Jumpering Used:

Standard Configuration

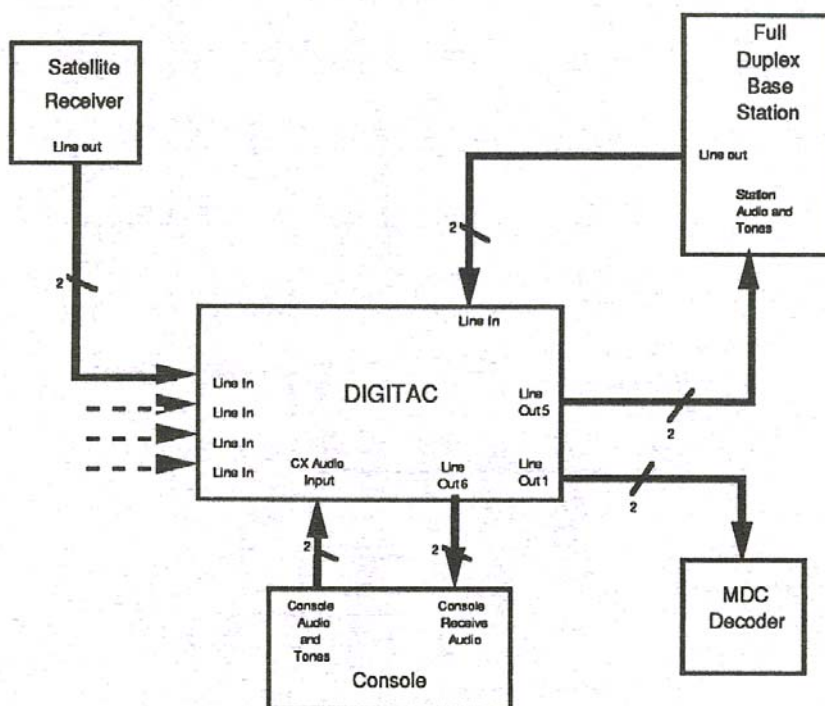


Figure 17. MDC Signaling

6.2.3 Multiple Consoles

This configuration is used in a conventional clear operation when 2 consoles are connected to the inputs on *Digitac*. There is a 4-wire interface between *Digitac* and both the base station and both consoles. This configuration only provides limited multiple console operation. In addition, only one console may use tone remote control.

Parameters Used:

RX:
Clear Audio Mute Time 0ms

TX:
Conventional Clear Configuration
Transmit Audio to Console Y

Jumpering Used:

Standard Configuration
Transmit Audio Board J612 Position A
Output Board J516 Position D

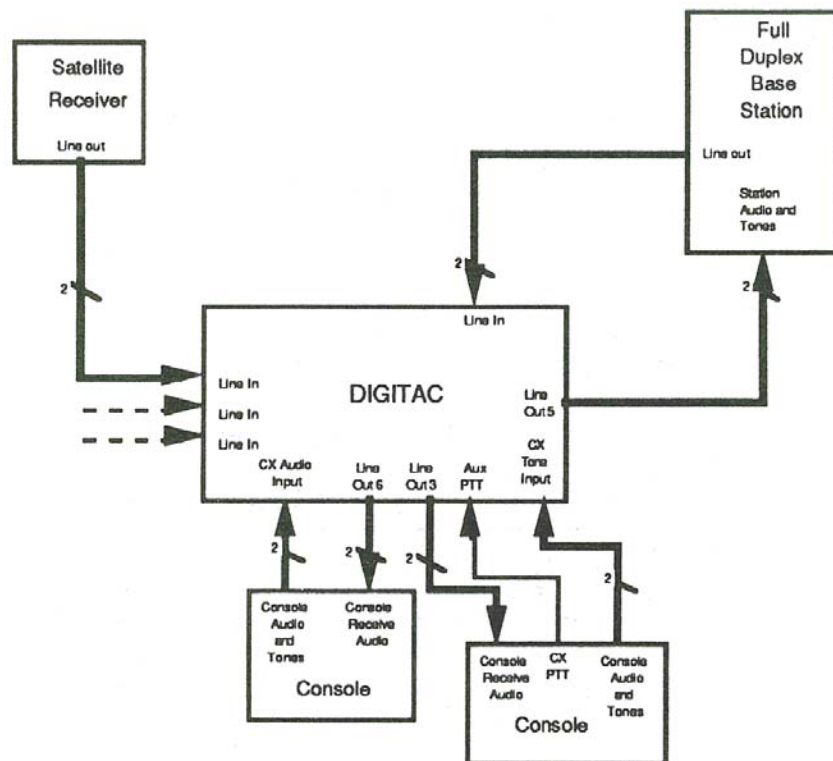


Figure 18. Multiple Consoles

6.2.4 Clear Only Phone Patch Connected to *Digitac*

This configuration is used when there is a conventional clear phone interconnect in a conventional clear configuration. There is a 4-wire interface between Digitac and the base station, console and the phone interconnect.

Parameters Used:

RX:
Clear Audio Mute Time 0ms

TX:
Conventional Clear Configuration

Jumpering Used:

Standard Configuration

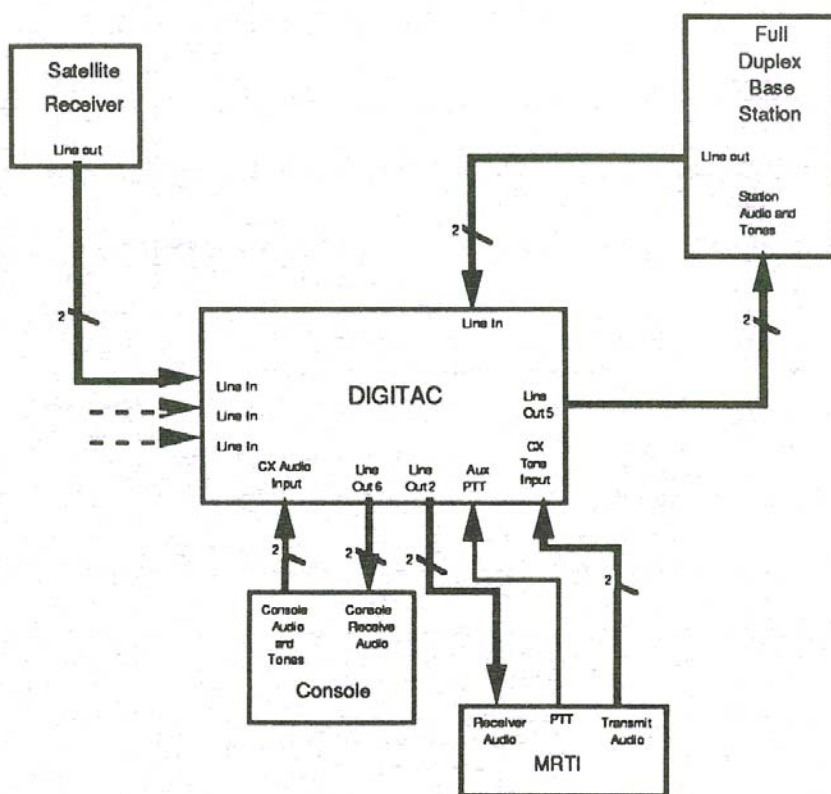


Figure 19. Clear Only Phone Patch Connected to *Digitac*

6.3 TRUNKED CODED

6.3.1 Standard Configuration

This configuration is used in a trunked coded configuration with modems on the inbound and outbound. There is a 4-wire interface between the *Digitac* and both the console and station. The Failsoft line from the station is connected to the CIU when a console is present.

Parameters Used:

RX:

Default Parameters

TX:

Trunked Coded Configuration

Jumpering Used:

Standard Configuration

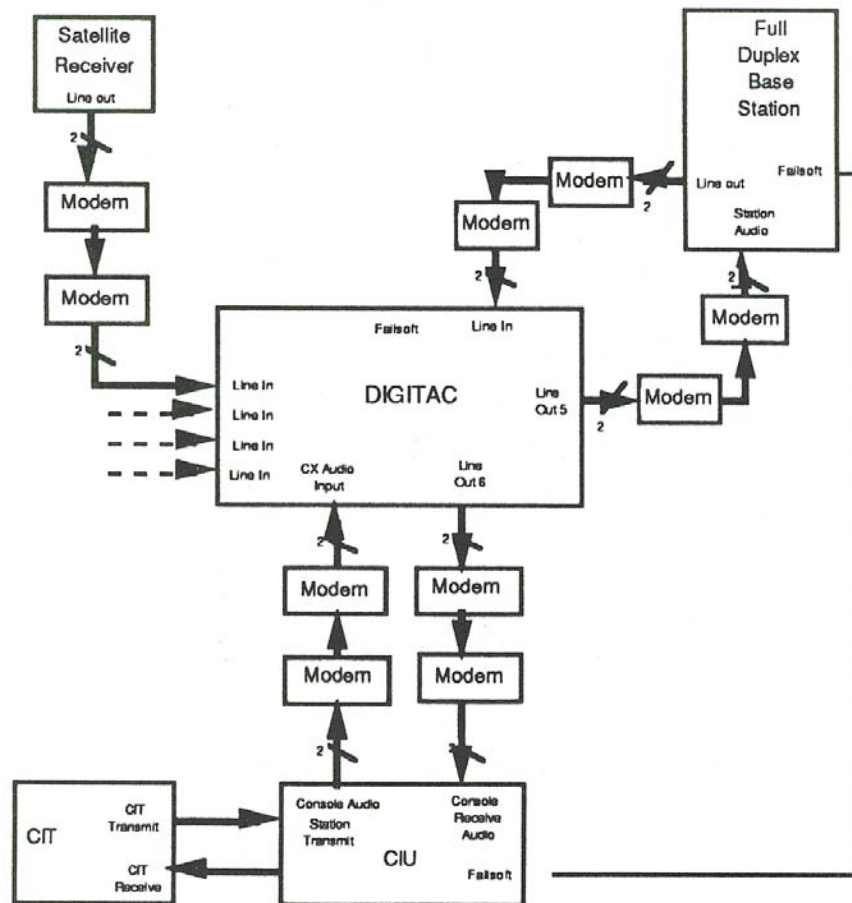


Figure 20. Standard Configuration

6.3.2 Non-Modem Connected Console

This configuration is used in a trunked configuration with modems on the receiver and station inbound and outbound. There is a 4-wire interface between the *Digitac* and both the console and station. The Failsoft line from the station is connected to the CIU.

Parameters Used:

RX:

Default Parameters

TX:

Trunked Coded Configuration

Jumpering Used:

Standard Configuration

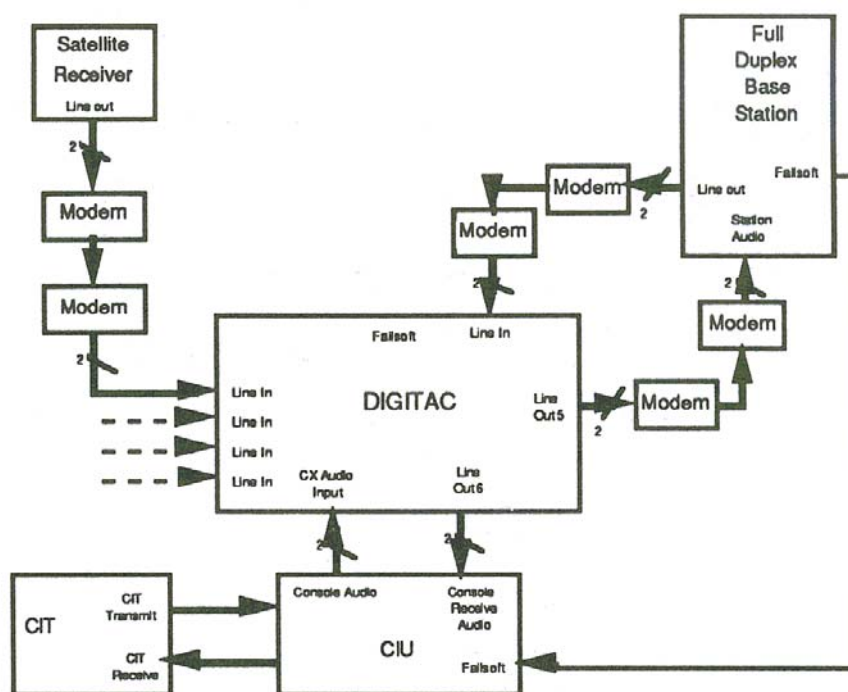


Figure 21. Non-Modem Connected Console

6.3.3 Non-Modem Connected Satellite Receivers and Station

This configuration is used in a trunked coded configuration with modems on the console inbound and outbound. There is a 4-wire interface between the *Digitac* and both the console and station. The Failsoft line from the station is connected to the CIU.

Parameters Used:

RX:
Differential Input Delay 30ms

TX:
Trunked Coded Configuration

Jumpering Used:

Standard Configuration

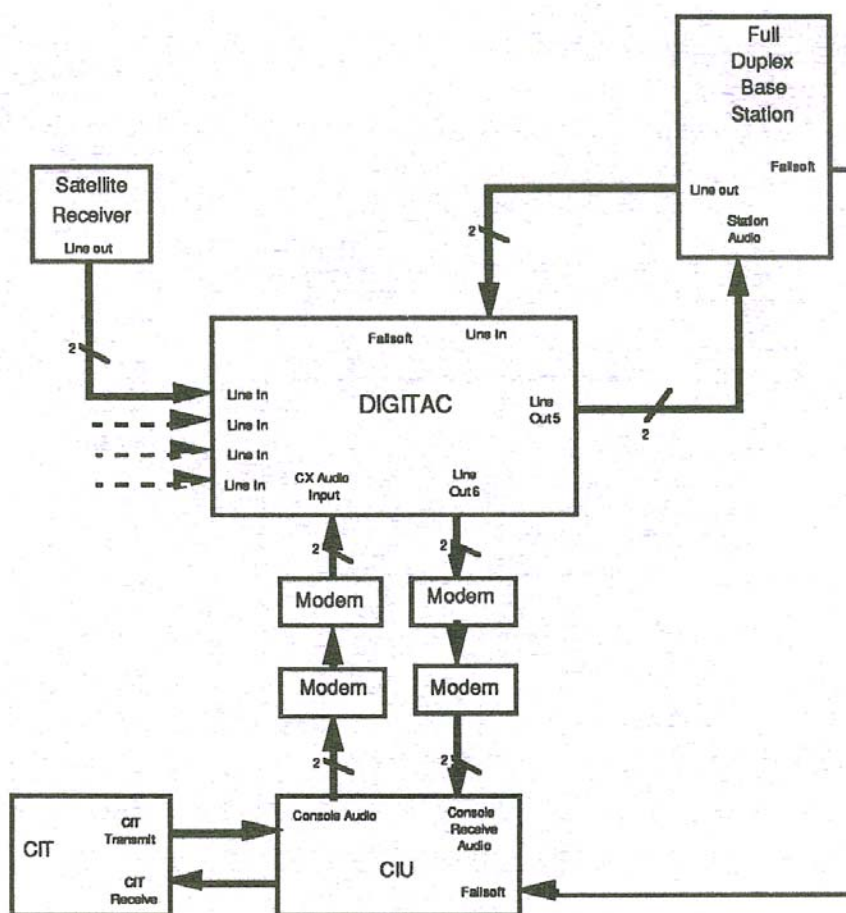


Figure 22. Non-Modem Connected Satellite Receivers and Station

6.4 TRUNKED CLEAR

6.4.1 Standard Configuration

This configuration is used in a trunked clear configuration. There is a 4-wire interface between the Digitac and both the console and repeater. There is also a line from the repeater to the *Digitac* indicating a failsoft condition.

Parameters Used:

RX:
Clear Audio Mute Time 0ms

TX:
Trunked Clear Configuration

Jumpering Used:

Standard Configuration

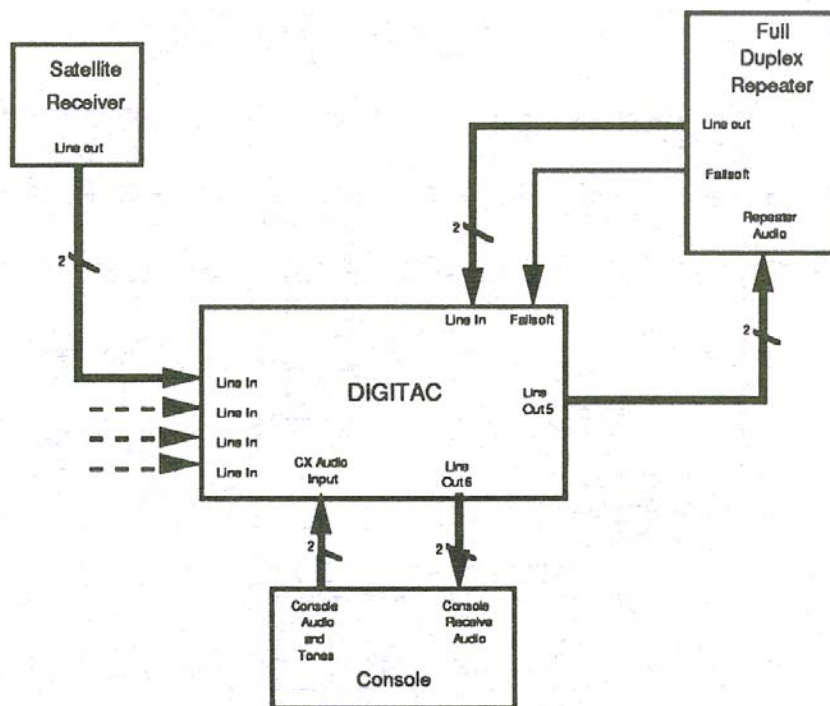


Figure 23. Standard Configuration

6.4.2 Multiple Consoles

This configuration is used in a trunked clear configuration with multiple consoles connected to the *Digitac*. There is a 4-wire interface between the *Digitac*, repeater and both consoles. There is also a line from the repeater to the *Digitac* indicating a failsoft condition.

Parameters Used:

RX:
Clear Audio Mute Time 0ms

TX:
Trunked Clear Configuration
Transmit Audio to Console Y

Jumpering Used:

Standard Configuration
Transmit Audio Board J612 Position A
Output Board J512 Position D

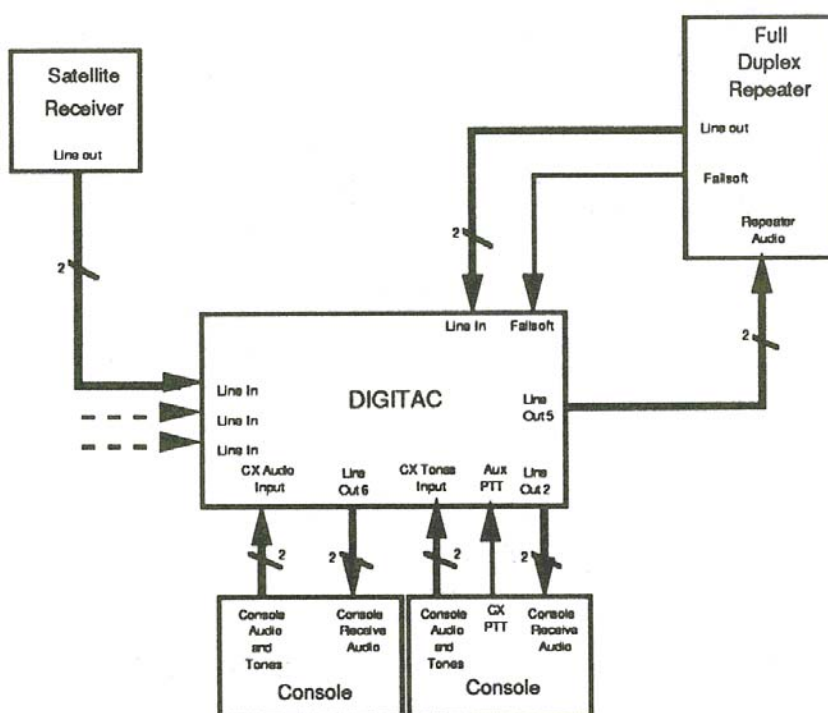


Figure 24. Multiple Consoles

6.4.3 Clear Only Phone Patch

This configuration is used in a trunked clear configuration with a clear only phone interconnect. There is a 4-wire interface between the *Digitac*, repeater, console and the phone interconnect.

Parameters Used:

RX:
Clear Audio Mute Time 0ms

TX:
Trunked Clear Configuration

Jumpering Used:

Standard Configuration

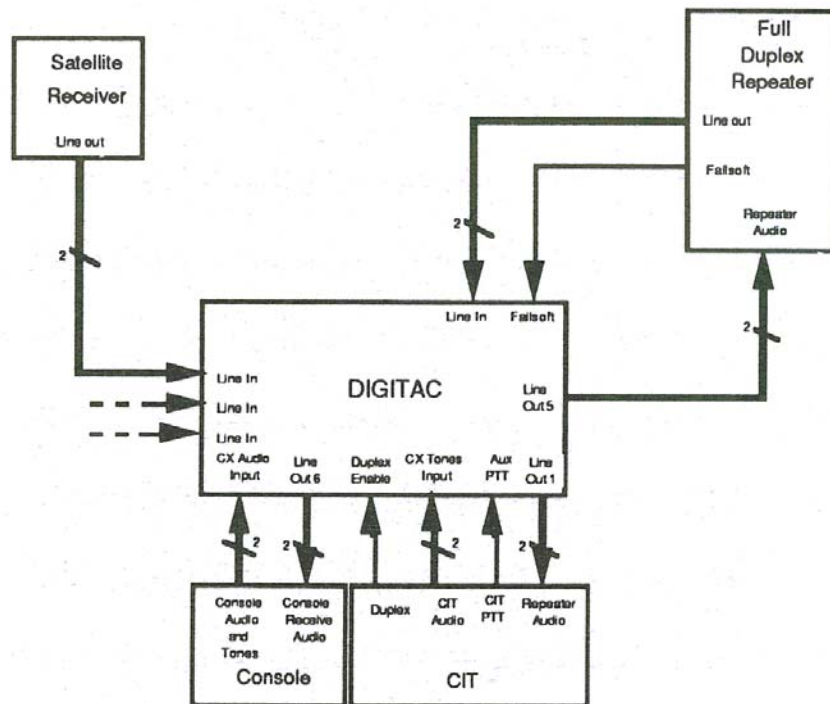


Figure 25. Clear Only Phone Patch

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7. RECEIVE PARAMETERS DESCRIPTION

7.1 CLEAR PARAMETERS

The clear parameters control the hold time, settle time, sample period, and mute time on clear signals into the comparator (all in milliseconds). These parameters also control the hysteresis used in the voting algorithm and the clear disable through the receive side of the *Digitac*. To access these parameters use the 'C' command.

```
C
Clear mode parameters:
To accept current values:      type <return>
To change:  type desired value then <return>
Settle time (msec)      = 150      150
Hold time (msec)        = 850      850
Sample period (msec)    = 0        0
Mute time (msec)        = 150      150
Hysteresis (dB)         = 2        2
Clear disable (Y/N)     = N        N
Finished.
```

- **Settle Time**
The settle time is how long the software comparator waits for the vote to settle before it locks the vote to any given channel. Minimum value recommended is 150 msec for reliable operation.
- **Hold Time**
The hold time is how long the comparator software waits after the setting time before the vote is allowed to unlock and change. This parameter is useful in MDC systems to avoid vote changes during MDC signaling time.
- **Sample Period**
The sample period is how long the software comparator waits between vote samples after the vote hold time has expired.
- **Mute Time**
The mute time controls a mute function at the beginning of a clear message. The mute prevents the clear audio from getting through the comparator and out the voted audio path. It is useful in muting DVP™ modem fast trains that happen in the clear mode before a coded message.
- **Hysteresis Value (dB)**
The hysteresis value controls the hysteresis used in the voting algorithm. In the clear mode the comparator measures the amount of noise present in the audio signal. The comparator initially votes the signal with the lowest noise level. After the first vote the comparator does not let the vote change until the noise on another channel is better than the noise on the voted channel by a margin that is set by the hysteresis.
- **Clear Disable (Y/N)**
If this setting is Yes, then the clear mode is disabled and the comparator does not operate in the clear mode.

7.2 EDIT DATE

To edit the DATE field of the personality, the 'D' command is used as follows. The date is entered by typing in a single line of characters followed by a carriage return. If a mistake is made then simply repeat the D command until the date is as desired. This parameter can be used at the user's discretion and does not affect operation. Ten characters are allowed in the date field. It is useful to document the date of the last change to the personality. The M (memo) command can be used to further annotate the settings.

```
D
The current date is:
Type in the new date followed by <return>.
06/15/88
```

7.3 EXIT PERSONALITY EDITING

This command is used to return to normal operation.

```
E
Personality may have changed.
To save the personality type W.
To really exit or quit retype E or Q.
```

7.4 FETCH DEFAULTS

This operation loads the software defaults into the RAM image of the comparator.

```
F
ROM defaults for the personality have been fetched.
```

7.5 GENERAL PARAMETERS

There are four general parameters on the Receive side of the *Digitac*: (1.) Line Failure Time, (2.) Activity Threshold, (3.) Disable Requests, and (4.) Output Status Tone Enables. To access the general parameters use the 'G' command as shown below.

```
G
General purpose parameters:
To accept current value:  type <return>.
To change:  type desired value then <return>.
Line failure times (sec):
  1 60      60
  2 60      60
  3 60      60
  4 60      60
  5 60      60
  6 60      60
  7 60      60
  8 60      60
Activity thresholds (dBm0):
  1 -14     -14
  2 -14     -14
  3 -14     -14
  4 -14     -14
  5 -14     -14
  6 -14     -14
  7 -14     -14
  8 -14     -14
Disable requests (Y/N):
  1 N       N
  2 N       N
  3 N       N
  4 N       N
  5 N       N
  6 N       N
  7 N       N
  8 N       N
Status tone enabled on primary audio bus (Y/N) = Y   Y
Status tone enabled on aux audio bus (Y/N)    = Y   Y
Finished.
```

7.5.1 Line Failure Time (sec) and Activity Threshold (dBm0)

These first two lines control the activity timeout for the inputs to the line in on the *DIGITAC*. The purpose of the activity timeout is to detect the presence of a broken input line and disable that line so that it does not corrupt the voting timeout is to detect the presence of a broken input line and disable that line so that it does not corrupt the voting process. An activity detector determines whether or not an input channel is silent by comparing the input level with the threshold level. If the level on the input line is below the threshold, then the

line is “silent” and a timer begins. If the timer expires before the line level exceeds the threshold then the channel is designated as failed and it is disabled from voting. The channel is restored upon return of status tone.

7.5.2 Disable Requests (Y/N)

These are Yes or No values. If a channel has a disable request asserted in the personality, then even the presence of status tone will not enable the channel. The channel can only be re-enabled from the personality.

7.5.3 Output Status Tone Enable (Y/N)

There are two places to enable status tone, either on the primary voted audio bus or the auxiliary voted audio bus. In applications where status tone is used to slightly idle time between messages, status tone must be enabled on the primary voted audio bus.

7.6 H or ? Help

This command displays a list of commands available at this operating level.

```
H
Personality editing commands are:
C Adjust clear
D Date
E Exit personality editing
F Fetch defaults
G General
H or ? Help
I Serial I/O
K Coded
M Memo
P Print
Q Quit service mode
R Read from nonvolatile storage
T Test
W Write to nonvolatile storage
```

7.7 EDIT SERIAL I/O

Configuring the serial port interface allows using a variety of terminal devices. The most important element that can be adjusted in the serial port interface is the baud rate. This parameter is adjusted using the DIP switch on the *Digitac* backplane interconnect board. Refer to the *Digitac* operator manual for setting this parameter. The factory setting is 9600 baud. It can be changed to 300, 1200 or 2400 baud.

SPECIAL NOTE

When the comparator first boots up, a diagnostic message is output with copyright information, etc. At this time in the booting process the NOVRAM has not been activated, so printing is done using predefined defaults and none of the following features are active. However, baud rate will be set correctly so the user will still get some amount of usable data.

```
I
Serial I/O parameters:
To accept current value: type <return>.
To change: type desired value then <return>.
New line characters = <CR> <LF>
Type 0: <CR> <LF>; 1: <CR>; 2: <LF> → <CR> <LF>
Line length = 64 64
Delay (msec) between characters = 4 4
Delay (msec) between lines = 0 0
Finished.
```

7.7.1 New Line Character

At the end of each output line the comparator must send a new line sequence. This sequence is definable by the user. The most generic end of line sequence is a return character followed by a line feed (Hex codes 0D 0A). The return character moves the platen to the far left while the line feed character advances the paper. Some terminals will return AND advance when either character is received. This adds a blank line between each text line which most likely will cause lines to roll off the top of the terminal device. By selecting either a return or a line feed this can be remedied. The best way to set this parameter is through experimentation.

7.7.2 Line Length

Since some terminal devices have only a limited width, it is possible for the comparator to roll all lines to a definable limit. Internally the diagnostic reports have been designed to use 64 character screens. Making the line length longer than this limit does not take advantage of bigger screens. However, lowering the line length will ensure that characters are not lost beyond the terminal devices capability. The drawback to this operation is that carriage returns can be placed at odd places in the printouts.

7.7.3 Character/Line Delays

Even though a terminal can receive data at a very high data rate, very few can keep up with this rate for extended periods of time. Printers are notorious for this problem as are computers that are used to emulate terminals. To overcome these limitations the user can place a small time delay between characters and a different delay between line feeds (which typically takes longer). These delays should be kept to a minimum for user convenience.

7.8 CODED PARAMETERS

The following parameters control the voting and buffering operations on the receive side of the *Digitac*. To access the coded parameters use the 'K' command.

```
K
Private (coded) mode parameters:
To accept current value: type <return>.
To change: type desired value then <return>.
All values are in msec.
Code detect time (nom) = 30 30
Code dropout time (nom) = 60 60
Max input delay diffrenc = 128 128
Additional delay (nom) = 0 0
Do you want to edit the buffer pad sizes? (y/n) → y
Voting buffer pad (nom) = 39 39
Output buffer pad (nom) = 40 40
Resulting coded throughput delay (nom) = 241 241
Coded disable (Y/N) = N N
Finished.
```

7.8.1 Code Detect Time (msec)

The code detect time is intended to represent the typical time delay between when a coded signal is present on the input line and when the code detector actually responds with a code detect. Since the software continuously stores all information that comes in through the line input, the software can retrieve information which came in shortly before the code detect actually occurs. As a result, the software does not have to discard any information that occurs at the beginning of a message.

7.8.2 Code Dropout Time (msec)

The code dropout time is the delay at the end of a coded message when data is being clocked in and the true code is not there. What this parameter controls is how far back into the data buffer it must go to discard bad data.

7.8.3 Differential Input Delay (msec)

The differential input delay is the amount of delay the comparator uses to enable it to compare bits from different channels. The delay parameter describes how much delay difference there may be between the signals on the line inputs. Minimizing this delay gives the fastest throughput.

7.8.4 Additional Delay (msec)

Additional delay is used to control the internal delay that is added before any bits can come out of the voted output. Typically, this might be used in synchronous encryption systems where a preamble is transmitted at the beginning of the message and it is very undesirable to truncate any of starting bits because of the risk of losing preamble.

7.8.5 Voting Buffer Pad and Output Buffer Pad

The voting buffer pad and output buffer pad control the intervals used in the software for the voting algorithm and the output clock synchronization. These "pads" may contribute to the total coded throughput delay so they are included in the personality settings. However, modification of the default settings is not recommended because of the risk that the coded voting algorithm may not perform optimally.

7.8.6 Coded Disable (Y/N)

If the coded disable is set to Yes, then the comparator will not operate in the coded mode and no coded output will be generated from the comparator.

7.9 EDIT MEMO

To edit the MEMO field of the personality, the M command is used as follows. The memo is entered by typing in a single line of up to 32 characters followed by a carriage return. If a mistake is made, then simply repeat the 'M' command until the memo is as desired. This parameter can be used at the customer's discretion and does not affect operation. Used with the date command, a simple audit trail can be setup to document the personality settings (or who made the last changes).

```
M
The current memo is:
Type in the new memo followed by <return>.
John Doe's DIGITAC
```

7.10 PRINT CURRENT SETTINGS

The current contents of the copy may be printed or displayed with the 'P' command exactly the same way that the personality was viewed after power-up above. The result of the 'P' command is as shown below.

```
P Command
Personality device status = blank
MEMO: John Doe's DIGITAC
DATE: 06/15/88
GENERAL:      1      2      3      4      5      6      7      8
Line failure time (sec) 60      60      60      60      60      60      60      60
Activity threshold (dBm0) -14     -14     -14     -14     -14     -14     -14     -14     -14
Disable requests (Y/N)  N       N       N       N       N       N       N       N
Output status tone enables: primary = Y      aux = Y

CLEAR: (times are in msec, hysteresis is in dB)
Settle time   = 150      Hold time = 50      Sample period = 0
Mute time     = 50       Hysteresis = 2      Clear disable = N
```

```

CODED: (times are in msec, disable is Y/N)
Code detect time = 30           Code dropout time = 60
Diff. input delay = 128        Additional delay = 0
Voting buffer pad = 39         Output buffer pad = 40
Coded disable = N

SERIAL I/O:
New line ASCII characters = <CR><LF>      Line length = 64
Delays (msec): character = 4             Line = 0

```

7.11 QUIT SERVICE MODE

This command is used to return to normal operation.

```

Q
Personality may have changed.
To save the personality type W.
To really exit or quit retype E or Q.

```

7.12 READ FROM NONVOLATILE STORAGE

This command re-reads the NOVRAM data into the RAM image so one can start editing over again.

```

R
Nonvolatile data has been read into RAM.

```

7.13 TEST NOVRAM

This command tests the NOVRAM device. If the personality device status is good, then everything is "ok". If the device status is blank, then RAM image should be written to the NOVRAM. If the device status is bad, then there are four types of errors: a type error, a format error, a checksum error and a value out of range error. A type error probably means that the NOVRAMs of the transmit and receive side are switched. A format error is usually caused by a software upgrade and the NOVRAM should be rewritten. If there is a checksum error, then this is most likely a bad part. One should overwrite the NOVRAM again and if the error does not go away the part should be replaced. If there is a value out of range error, then the values should be entered and written to the NOVRAM again.

```

T
Personality device status = good

```

7.14 WRITE TO NONVOLATILE STORAGE

This command will transfer the values in the NOBRAM RAM image into the NOVRAM ROM image.

```

W
RAM image now saved in the personality device.

```

8. TRANSMIT PARAMETERS DESCRIPTION

8.1 HIGH LEVEL GUARD TONE PARAMETERS

The user can control several parameters that concern high level guard tone. All parameters in this section can be accessed using the A command.

```

A
HIGH LEVEL GUARD TONE:
To accept DEFAULT value:  type <d>.
To accept CURRENT value:  type <spacebar> or <return>.
To change:  type desired value then <return>.
Level      (dB0) = ( 0 )      0 :      0
Duration (msec) = ( 120 )    120 : 120
On for Clear Key-up (Y/N) = ( Y )  Y :   Y
On for Coded Key-up (Y/N) = ( Y )  Y :   Y
Edit HLGTT Decode Parameters? (y/n) → y
Decode Frequency Tolerance (dB0) = ( 10 )      10 : 10
Decode Level Tolerance (dB0) = ( 10 )      10 : 10
Decode Integrator Up Gain ( % ) = ( 8 )      8 :   8
Decode Integrator Down Gain ( % ) = ( 1 )    16 : 16
Decode Variance Threshold = ( 26 )    26 :   26
Finished.

```

8.1.1 Level (0, -10, -20, -30 dB)

This parameter sets both the encode and decode level of high level guard tone relative to test tone. Normally, high level guard tone is sent through the system at 0 dB relative to test tone. The user can optionally set this level to 0, -10, -20, or -30 dB. On the tone input port, the corresponding gain will be inserted to compensate for the expected lower levels. On the tone encode side; appropriate attenuation will be installed to get the level to comply. This parameter is useful for solving cross talk problems and phone line compatibility issues.

8.1.2 Duration (0 to 10000 msec)

This parameter can be used to adjust the duration of the high level guard tone. It is used on both the decode and encode side of the comparator. By selecting a longer high level guard tone, the immunity to falsing detect increases at the expense of system access time. At this time 60 msec seems to be the shortest recommended duration for reliable tone detection. Another parameter is provided to turn off the encoding of high level guard tone entirely. This is done in systems that are using logic coupled PTTs. Shortening the duration of high level guard tone to zero is not recommended because of the effect it has on tone decoder operation.

8.1.3 On For Clear Key-Up (Y/N)

For the purposes of keyups, there are two flags used to control whether high level guard tone is sent before messages are started. The first is used to control the presence before clear messages, while the second is used before coded messages. The most common situation is to eliminate keyup tones before coded messages. This technique is called Key On Data. The system advantage gained is that modem fast trains can easily be suppressed at the transmitter. If control tones are encoded before coded messages, there is a time period after the last function tone is received at the station until data is present at the station when a modem will be generating some random bits. If the station is on the air after the last control tone, this "garbage" goes out over the air. To suppress this "garbage", some systems have gone to Key On Data operation. The modem still sends its "garbage" to the station, but because no keyup tones were sent it does not go out over the air. Later when the good data arrives the station keys up. This technique also shortens coded access time. The only reason the user may wish to remove high level guard tone before clear messages is when logic level control of the station is performed.

8.1.4 On For Coded Key-Up (Y/N)

See Section 8.1.3, On For Clear Key-Up.

DISCLAIMER

Minor adjustments to the following high level guard tone parameters can be used under special system conditions. Radical changes may produce indeterminate decoder performance.

8.1.5 Decode Frequency Tolerance (0 to 255 Hz)

This parameter is only modifiable by requesting to modify decode parameters. This parameter sets the decode frequency tolerance for high level guard tone. Some tolerance to

frequency variations is required to compensate for tolerances in the guard tone source, resolution and tolerance in the comparator, and for frequency translation on phone lines. As far as the comparator goes, both resolution and tolerances are good enough to allow operation with a frequency tolerance of about 10 Hz (2185 to 2165), but other products (and phone lines) are not quite that good.

8.1.6 Decode Level Tolerance (0 to 50 dB)

In order to further increase the reliability of the tone decoder, an added level restriction was placed on detection. The source of this parameter measurement plays a critical role in selecting its value. Using the analog to digital converter, a measurement of the incoming signal is made. This measurement has a very little resolution (default = ± 10 dB) so care must be exercised so that the user does not request more precision than the A/D can provide.

8.1.7 Decode Integrator Up Gain (0 to 100%)

As the high level guard tone detector operates, it maintains an integrator to determine if the tone is present. When this integrator reaches 100%, tone detection is achieved. Each good tone segment increments the level of the integrator by the integrator up gain amount. By setting the integrator up gain to a large number the user can decrease the amount of good tone required for signal detection. This parameter is tied to the duration of high level guard tone, so when the user modifies the duration, this parameter is scaled to achieve detect in the new time frame. However, by selecting to modify the extra decode parameters for high level guard tone, the user has an opportunity to further adjust this parameter.

8.1.8 Decode Integrator Down Gain (0 to 100%)

This parameter is very similar to the Up Gain parameter previously discussed. This parameter is used as the decay factor when a tone segment is received that does not resemble high level guard tone. This parameter needs to be set so that if a different tone is being received the tone decoder will not false detect, and yet normal line does not cause the integrator to be zeroed out too quickly.

8.1.9 Decode Variance Threshold (0 to 255)

The high level guard tone variance determines how much short-term frequency variance can be tolerated on the high level guard tone. Each cycle of the incoming guard tone is recorded. If the average period of the incoming cycles is close enough to the guard tone frequency, a possible detection can occur. In addition, the variance of the periods is also analyzed. A high variance in the frequency indicates that there are other frequencies present (possibly voice or noise), while a low variance indicates that the tone is virtually pure. By adjusting the variance parameter the user may select the amount of spectral purity required to allow tone detection.

8.2 CONSOLE RECEIVE AUDIO PARAMETERS

These parameters control what audio is routed back as console receive audio.

```
B
Console Receive Audio Parameters:
Defaults are in parentheses followed by current setting.
To accept DEFAULT value: type <d>
To accept CURRENT value: type <spacebar> or <return>.
To change: type desired value then <return>.
Console Receive Audio Mute Time (msec) = ( 0 )      0      0
Notch Console Audio      (Y/N) = ( N )      N:      N
Transmit Tones to Console (Y/N) = ( N )      N:      Y      Y
Transmit Audio to Console (Y/N) = ( N )      N:      Y      Y
Repeater Audio           [Y/N] = ( Y ) Y:      Y
Console Audio            [Y/N] = ( Y ) Y:      Y
Handset Audio            [Y/N] = ( Y ) Y:      Y
Auxiliary Audio [Y/N] = ( Y ) Y:      Y
Finished.
```

8.2.1 Console Receive Audio Mute Time (0 to 10,000 msec)

Console receive audio that is routed through the comparator can be optionally muted to help cover the presence of signaling information in messages. Specifically, in systems that use MDC-600 (or 1200) signaling, the user can set this parameter so the console operator does not hear signaling arriving from the field. Users familiar with the receive portion of the comparator know that it, too, is capable of this operation. However, in systems that require decoding of these tones AND blocking in the comparator, this parameter becomes very useful. The user would set up the system so that the receive portion of the comparator does not block any portion of the receive audio. The output of the receive portion can then be routed to an MDC-600 or (1200) decoder box (a GCC-80 for example). The console (and associated CIU II) can then be set to eliminate the MDC-600 (or 1200) signaling without effecting the decoding. Note that the muting operation in the transmit controller simply runs independently of that done in the receive portion of the comparator.

8.2.2 Console Audio Notch Filter (Y/N)

This parameter allows the user to notch console receive audio. It is intended to be used in trunking systems where failsoft is signaled using low level guard tone. At this time this parameter has no use in conventional systems.

8.2.3 Transmit Tones to Console (Y/N)

This parameter allows the user to send the tones that are going out to the transmitter back to the console(s). This parameter should only be used in a multiple console configuration so the other consoles can hear what tones are being sent out to the transmitter.

8.2.4 Transmit Audio to Console (Y/N)

This parameter allows the user to send the audio, which is going out to the transmitter, back to the console(s). It should only be used in a multiple console configuration. The user can choose which of the following audio signals will be sent back to the console:

- Repeater Audio
- Console Audio
- Handset Audio
- Auxiliary Audio

If the user does not want transmit audio sent back to the console, indicated by entering N above, then the audio that is routed back to the console is only the Repeater Audio and the Handset Audio.

8.3 EDIT CONTROL TONE SEQUENCES

Control of the comparator can be simplified using tone remote control. By sending a tone sequence to the comparator, the user may enable or disable a number of features. The user may select exactly what tone sequence controls what feature. Each tone sequence must be preceded by high level guard tone and the editor for sequences assumes this. In addition, the number of tones to decode must be set properly to ensure that the decoder performs properly.

There are two features that can be used to enhance the versatility of tone control. The first is, not allowed tone sequences. By selecting a zero at the editor level, a user may disallow a tone command from being accessed by a remote user. This is useful for solving "what if" problems when a feature should simply not be recognized.

The second feature is wildcards. A wildcard is simply an ability to allow any frequency to activate a command. A common use for this feature is in two function tone setups. The user can make the first tone control one feature while the second tone controls another feature. For instance, the first tone could be used to enable or disable the repeater. The second could be used to enable or disable clear audio summing. In this case, the first and last function tone are not really linked so it doesn't make sense to try and program them in terms of one another. Therefore the user should use wildcards to assure correct interpretation of the tones.

The next sections describe the control functions that can be performed using tone remote control.

```
C
Set Tone Remote Control Sequences
Enter the number of the sequence you wish to modify
followed by a <return>. Use zero to indicate all
sequences:
0 ) All sequences
1 ) Repeater Enable
2 ) Repeater Disable
3 ) Console Enable
4 ) Console Disable
5 ) Auxiliary Enable
6 ) Auxiliary Disable
7 ) Select Auxiliary Priority
8 ) Select Console Priority
9 ) Select Repeater Priority
10 ) Select First In Priority
11 ) Priority Revert
12 ) Clear Summing Enable
13 ) Clear Summing Disable
Selection: 1
Set the Repeater Enable tone sequence
Define Tone Sequence:
High Level Guard Tone is automatically assumed
To accept CURRENT setting: type <spacebar> or <return>
To change: type the correct tone frequency and <return>
To disallow the sequence entirely: type 0 <return>
To request wildcard: type 1 <return>
To accept default: type D
The current sequence is:      GT,    1450
The default sequence is:      GT,    1450
What should the first function tone be:
The new sequence is :        GT,    1450
Finished
```

8.3.1 Repeater Enable / Disable

Repeater disable allows the console operator to disable the repeater action of the comparator however, the comparator can still be accessed by the console operator. This command sequence will be passed to the station to disable incabinet repeat the same way all tone sequences are passed through the comparator to the station.

8.3.2 Console Enable / Disable

Console disable disallows operator from accessing the comparator except for the re-enable command. This command is intended to be used when a console is connected in parallel to two or more transmitter control units. The transmitter control units can each control a particular transmitter using a dedicated wireline hook up. By defining the console disable sequence differently, the console operator can select the unit to talk to and proceed to do just that while the other transmit control module ignores all key up sequences. During this mode the disabled transmit control unit can still operate in the repeat mode (provided the repeater is enabled).

8.3.3 Auxiliary Enable / Disable

Auxiliary disable disallows the auxiliary device from accessing the comparator. This command is intended to be used when an auxiliary device is connected to the input of the comparator on the console tone input lines.

8.3.4 Auxiliary Priority, Console Priority, Repeat Priority, First In Priority, Priority Revert

These five control sequences are used to control the priority mode by tone remote control. The first three simply raise the associated input to the top of the priority "pile". Thus it can be used to override the field programmed priority mode. This change can be done at any time and takes effect immediately. For instance, assume the

service technician has programmed the NOVRAM for Repeat/Console/Auxiliary Priority. Next, assume that a lengthy repeat transmission is in progress. Normally if the console operator tries to use the station, because of the repeat priority, the console operator will be ignored. However, if the console operator either precedes his message with a console priority command or uses a special keyup sequence which has been predefined to also select console priority, the console can take over the system. The last command available simply tells the comparator to revert to the predefined priority to allow the console operator to put the priority mode back to the NOVRAM controlled value.

8.3.5 Clear Summing Enable/Disable

The final feature controllable by tone remote control is clear audio summing. If all inbound signals are clear mode, it is possible to add them together instead of switching to a complete new signal. This operation can be selected by the console operator using a simple tone command sequence and the exact sequence used is selectable by the user.

8.4 EDIT DATE

To edit the DATE field of the personality the 'D' command is used as follows. The date is entered by typing in a single line of characters followed by a carriage return. If a mistake is made then simply repeat the 'D' command until the date is as desired. This parameter can be used at the user's discretion and does not affect operation. Ten characters are allowed in the date field. It is useful to document the date of the last change to the personality. The M (memo) command can be used to further annotate the settings.

```
D
The current date is:
Type in the new date followed by <return>.
06/15/88
```

8.5 EXIT PERSONALITY EDITING

This command is used to return to normal operation.

```
E
Personality may have changed.
To save the personality type W.
To really exit or quit retype E or Q.
```

8.6 FETCH DEFAULTS

This operation loads the software defaults into the RAM image of the comparator.

```
F
ROM personality defaults for a Conventional Coded System have been fetched.
```

8.7 EDIT GENERAL PARAMETERS

The general parameter list includes those parameters that do not lend themselves to any particular group. However, these parameters are important for providing a system engineer complete flexibility. They can be accessed by typing 'G'.

```
G
GENERAL PARAMETERS:
To accept (DEFAULT) value: type <d> or <D>.
To accept CURRENT value: type <return>.
To CHANGE: type desired value then <return>.
Tones at +6dB (Y/N) = (N) N: N
Internal Repeater Disable (Y/N) = (N) N: N
Internal Console Disable (Y/N) = (N) N: N
Internal Auxiliary Disable (Y/N) = (N) N: N
```

```

Tones in on Console audio bus (Y/N) = (N)  N:  N
Send Failsoft Tones to Console      (Y/N) = (N)  N:  N
Transmit Audio Notch Filter (Y/N) = (N)  N:  N
Tones out on Transmit Audio Bus      ( Y/N ) = ( N ) N:  N
Enable CIT Duplex Logic Input (Y/N) = (N)  N:  N
Set Priority Request ( 1/2/3 ):
    1 = Console/Repeater/Auxiliary
    2 = Console/Auxiliary/Repeater
    3 = Repeater/Console/Auxiliary
    4 = Repeater/Auxiliary/Console
    5 = Auxiliary/Console/Repeater
    6 = Auxiliary/Repeater/Console
    7 = First In Priority
Default Priority: Console/Repeater/Auxiliary
Current Priority: Console/Repeater/Auxiliary
Enter Selection:
New Selection: Console/Repeater/Auxiliary
Edit Additional Parameters . . . . . ( y/n ) ? → y
Encode Filter Select Threshold ( Hz ) = ( 1300 ) 1300: 1300
Suppress Console Tone Regeneration ( Y/N ) = ( N ) N:  N
Finished.

```

8.7.1 Tones at +6 dB (Y/N)

In order to provide greater noise immunity when decoding tones or control tones, it is possible to boost the level of control tones by 6 dB. This has the effect of boosting the output control tone level by 6 dB. In addition, this parameter attenuates incoming tones by 6 dB to compensate for the expected higher input level. This feature compensates high level guard tone, function tones and low level guard tone equally.

8.7.2 Internal Repeater Disable (Y/N)

This variable inhibits repeater audio from passing through the transmit side of the *Digitac*.

8.7.3 Internal Console Disable (Y/N)

This variable inhibits console audio from passing through the transmit side of the *Digitac*.

8.7.4 Internal Auxiliary Disable (Y/N)

This variable inhibits auxiliary audio from passing through the transmit side of the *Digitac*.

8.7.5 Tones In On Console Audio Bus (Y/N)

In order to control whether the interface to the console is two or four wires, the user simply selects tones on the console audio line for two wire interfaces. If tones are not on the console audio line they are assumed to enter on the tone port and a six-wire interface is assumed.

8.7.6 Send Failsoft Tones To Console (Y/N)

For clear trunking systems where the user wishes to signal failsoft back to the console, a parameter exists to send tones to the console. This parameter completely eliminates the ability of the comparator to control a station by tone control since there is only one tone generator on the comparator. However, a hard wire interface to a station is still allowed. This parameter has no use in conventional systems. In addition, since the CIU II is responsible for failsoft control, it has no real use in coded trunking systems.

8.7.7 Transmit Audio Notch Filter (Y/N)

The transmit audio notch filter is intended to be used on audio sent to the station. It is necessary to notch audio to the station while two wire interfaces are being used to the transmitter and adding low level guard tone to the audio signal is required. It doesn't matter what source is being used for station audio, if the notch is to be used

it will be. The only exception is when coded audio is being selected. It would be counter-productive to notch coded signals.

A common problem that happens with this parameter is the operator selects tones on the transmit audio line (described below) for use with a two wire interface to the transmitter, but does not enable the transmit audio notch. With this setup, the station mysteriously drops out every so often during console activity. The console is sending low level guard tone and the comparator is adding it's own low level guard tone in (without notching out the consoles guard tone). As these two sine waves add, they either double the level of guard tone or they completely cancel each other out. However, since the low level guard tone frequencies are probably slightly different, the two frequencies will 'beat' against each other. This causes the transmitter to suddenly drop out. This problem is quite easy to spot on an oscilloscope connected to the transmit audio line.

8.7.8 Tones Out On Transmit Audio Line (Y/N)

The user can optionally select whether the transmit audio line has control tones on it. This option along with the transmitter notch filter allow the user to specify a two or four wire interface to the transmitter. It will place guard tone and function tone on the station audio line while muting voice audio and will add low level guard tone to the audio during a message.

8.7.9 Enable CIT Duplex Logic Input (Y/N)

This input is used to enable duplex through the comparator for clear only phone patch in clear trunking systems. In addition to allowing clear only phone patch, it also enables clear audio summing in the comparator. This parameter's use may vary from one system to another.

8.7.10 Set Priority Request (1/2/3)

Since it is possible for more than one input signal to the comparator to become active, priority control is required. The handset and front panel have the highest priority and the user has no control over this. However, between the auxiliary and console operators and repeater operation there are six types of priority that are selectable. They are defined in the following way (i.e. Console/ Repeater/ Aux). This format translates to console having top priority, repeat audio having second priority, and auxiliary input (second console or phone patch) having bottom priority. The order of the priorities is always determined by the listing. The first one listed has top priority, the second one listed has middle priority, and the third one listed has bottom priority. The other priority mode is called first in priority. The first user (console, repeat, or auxiliary) that accesses the system has control until the end of their message. When first in priority is used, after the first user message has been completed, the next user is allowed to use the system. The second user has to be finished before a third can access the system.

8.7.11 Encode Filter Select Threshold

When function tones (and guard tone) are generated, a filter is used to make the tones more sinusoidal. Because of the wide frequency range inherent in function tones, the filter used to limit harmonics in the square wave has two possible corner frequencies that the software selects based on the tone frequency. This parameter sets the cutoff frequency for the filter selection. For frequencies below the cutoff point, the lower corner is used, while frequencies above this point utilize the upper corner. This feature is intended to allow some freedom in changing the filter performance for special applications.

8.7.12 Suppress Console Tone Regeneration (Y/N)

Some systems use hardware connections between the station and the comparator, which means that control tones do not need to be sent to the station. However, they might still maintain a tone remote control connection with the console to allow the console to control comparator features. For these systems the user can disable tone regeneration of console tones out to the station. In addition the user may wish to shut off all tones used during repeater operation but this is up to the user. Disabling console tone regeneration will simply mean that console tones received and decoded at the comparator will not be regenerated to the station.

9. H OR ? HELP

This command displays a list of commands available at this operating level.

```
H
Personality editing commands are:
A Edit High Level Guard Tone Parameters
B Edit Console Receive Audio Parameters
C Edit Control Tone Sequences
D Edit Date
E Exit Personality Editing
F Fetch Defaults
G Edit General Parameters
H or ? Help
I Edit Serial I/O
K Edit Coded Parameters
L Edit Low Level Guard Tone Parameters
M Edit Memo
N Edit Function Tone Parameters
P Print Current Settings
Q Quit Service Mode
R Read From Nonvolatile Storage
S Edit Configuration
T Test Novram
U Edit Keyup Keydown Timing
V   Edit Valid Tone List
W   Write to Nonvolatile Storage
X   Set Transmitter Interconnect
Z   Edit Failsoft Parameter
```

10. EDIT SERIAL I/O

Configuring the serial port interface allows using a variety of terminal devices. The most important element that can be adjusted in the serial port interface is the baud rate. This parameter is adjusted using the DIP switch on the comparator motherboard. The reader is referred to the comparator operator manual for setting this parameter. The factory setting is 9600 baud, and can be changed to 300, 1200 or 2400 baud.

SPECIAL NOTE

When the comparator first boots up, a diagnostic message is output with copyright information and such. At this time in the booting process the NOVRAM has not been activated so printing is done using predefined defaults and none of the following features are active. However, baud rate will be set correctly so the user will still get some amount of usable data.

```
I
Serial I/O parameters:
To accept current value: type <return>.
To change: type desired value then <return>.
New line characters = <CR> <LF>
Type 0: <CR><LF>; 1: <CR>; 2: <LF> → <CR> <LF>
Line length = 64 64
Delay (msec) between characters = 4 4
Delay (msec) between lines = 0 0
Finished.
```

10.1 NEW LINE CHARACTER

At the end of each output line the comparator must send a new line sequence. This sequence is definable by the user. The most generic end of line sequence is a return character followed by a line feed (Hex codes 0D 0A). The return character moves the platen to the far left while the line feed character advances the paper. Some terminals will return AND advance when either character is received. This adds a blank line between each text

line, which will probably cause lines to roll off the top of the terminal device. By selecting either just a return or just a line feed this can be remedied. Probably the best way to set this parameter is through experimentation.

10.2 LINE LENGTH

Since some terminal devices have only a limited terminal width, it is possible for the comparator to roll all lines to a definable limit. Internally, the diagnostic reports have been designed to use 64 character screens. Making the line length longer than this limit will not take advantage of bigger screens. However lowering the line length will ensure that characters are not lost beyond the terminal devices capability. The drawback to this operation is that carriage returns can be placed at odd places in the printouts. This problem is unfortunately unavoidable.

10.3 CHARACTER / LINE DELAYS

Even though a terminal can receive data at a very high data rate, very few can keep up with this rate for extended periods of time. Printers are notorious for this problem as are computers that are used to emulate terminals. To overcome these limitations the user can place a small time delay between characters

and a different delay between line feeds (which typically takes longer). These delays should be kept to a minimum for user convenience.

11. EDIT CODED PARAMETERS

```
K
CODED:
Defaults are in parentheses followed by current setting.
All values are in milliseconds.
To accept DEFAULT value: type <d>.
To accept CURRENT value: type <spacebar> or <return>.
To change: type desired value then <return>.
Code Detect Time = ( 30 )      30:   30
Code Dropout Time = ( 40 )     40:   40
Additional Delay = ( 0 )       0:    0
Edit Buffer Parameters? ( y/n ) → y
Alignment Search Depth = ( 110 ) 110:  110
Repeater Buffer Size = ( 600 )    600:  600
Console Buffer Size = ( 600 ) 600:    600
Additional Output Delay = ( 50 )  50:    50
Repeater Buffer Post Overflow Depth = ( 450 ) 450:  450
Console Buffer Post Overflow Depth = ( 450 ) 450:  450
Nominal Coded Throughput Delay = 112
Finished.
```

11.1 CODE DETECT TIME (0 to 10000 msec)

The code detect time parameter defines how long before a code detect occurred that console DVP data was available (a similar parameter for repeater code detect time is available through the receive side NOVRAM editor). While the transmit controller module is idle, it is constantly clocking data through its console data buffer. After a code detect occurs the comparator looks back in the data buffers to recover any data that entered the comparator before the code detect occurred. If this parameter is set too short, data will be lost on the front of the message, while setting it too long will cause reclocked "garbage" to be included at the beginning of the message. This parameter need only change if the code detect chip on the comparator changes, or the nature of the data changes enough to significantly effect code detect times.

11.2 CODE DROPOUT TIME (0 to 10000 msec)

Similar to the code detect time parameter, the code undetect time dictates the amount of time before the console code detect was lost that console DVP data was actually unavailable. If this parameter is set too short, reclocked "garbage" could be appended to the end of the actual message. If this parameter is set too long, data could be truncated from the end of the message. This parameter need only change if the code detect chip on the comparator changes, or the nature of the data changes enough to significantly effect code undetect times.

11.3 ADDITIONAL DELAY (0 to 10000 msec)

The output requested delay parameter allows the user to extend the coded throughput delay beyond the minimum throughput delay. A value of zero indicates that no additional delays are requested by the user. This is by far the most user-adjustable coded parameter, and generally the only one that will be used. The default value for this parameter is zero, so any change to this parameter will increase coded throughput delay.

11.4 ALIGNMENT SEARCH DEPTH (0 to 10000 msec)

Under normal operation, the *Digitac* receive module generates a global best and a global majority data stream. These two data streams do not automatically arrive time aligned at the transmit control module. Thus, the transmit control module must search for the relative time positioning of these two data streams. The process of searching for alignment can be very costly in terms of software performance. This parameter allows the search to be restricted to a range less than the entire extent of the input buffers. This parameter is NOT affected by the interchannel delay on the receive portion of the comparator. Generally, this parameter need not be changed from its default value.

11.5 REPEATER BUFFER SIZE (0 to 10000 msec)

The repeater input store time parameter dictates the maximum amount of coded data stored in each of the repeater input buffers. An adequate amount of data must be stored to allow for the gradual synchronization with the input clock rate coupled with the additional coded output delays. This parameter does not affect coded throughput delay, but must always be set greater than the maximum delay expected in order to prevent premature buffer overflow conditions.

11.6 CONSOLE BUFFER SIZE (0 to 10000 msec)

Similar to the repeater input store time, the console input store time dictates the amount of DVP data that can be stored in the console input buffer. An adequate amount of data must be stored to allow for the gradual synchronization with the input clock rate coupled with the additional coded output delays. This parameter does not affect coded throughput delay, but must be set greater than the maximum delay expected in order to prevent premature buffer overflow conditions. When console input data is not selected for transmit control module output, any inbound data is stored to the extent of this buffer size until either the console input message has ended or the console input stream has been selected for output.

11.7 ADDITIONAL OUTPUT DELAY (0 to 10000 msec)

The output shock absorber defines the amount of data retained in the output buffer before transmission begins. This parameter sets the basis for the minimum coded throughput delay of the system. Software loading and throughput delays may dictate some fine tuning of this parameter, but in general this parameter need not be changed from its default value.

11.8 REPEATER BUFFER POST OVERFLOW DEPTH

The repeater post overflow time defines the size of a repeater input buffer after the buffer has overflowed. Overflow is detected by the buffer depth reaching the repeater input store time. This value is restricted to values greater than the repeater ready threshold time. The value to which this parameter is set becomes apparent in the delay time of repeater messages which began while another coded data stream had priority.

11.9 CONSOLE BUFFER POST OVERFLOW DEPTH

Like the repeater post overflow time, the console post overflow time defines the size of a console input buffer after the buffer has overflowed. Overflow is detected by the buffer depth reaching the console input store time. This value is restricted to values greater than the console ready threshold time. The value to which this parameter is set becomes apparent in the delay time of console messages which began while another coded data stream had priority.

12. EDIT LOW LEVEL GUARD TONE PARAMETERS

The user can control several parameters that concern low level guard tone. All parameters in this section can be accessed using the 'L' command.

```
L
LOW LEVEL GUARD TONE:
To accept DEFAULT value: type <d>.
To accept CURRENT value: type <spacebar> or <return>.
To change: type desired value then <return>.
Level (dB0) = (-30)      -30:      -30
LLGT Tone On (y/n) = (Y)  Y:      Y
Edit LLGT Decode Parameters? (y/n) → y
Decode Frequency Tolerance (Hz) = (10) 10: 10
Decode Level Tolerance (dB) = (10) 10: 10
Decode Activity Time (msec) = (75) 75: 75
Decode Activity Threshold (dB) = (-15) -15: -15
Decode Integrator Up Gain (%) = (1) 1: 1
Decode Integrator Down Gain (%) = (1) 1: 1
Decode Variance Threshold (dB) = (32) 32: 32
Finished.
```

12.1 LEVEL (0, -10, -20, -30 dB)

This parameter sets both the encode and decode level of low level guard tone relative to test tone. Normally low level guard tone is sent through the system at -30 dB relative to test tone. The user can optionally set this level to 0, -10, -20, or -30 dB. On the tone input port the corresponding gain will be inserted for lower guard tone levels. On the tone encode side, appropriate attenuation will be installed to get the level to comply. This parameter is useful for solving cross talk problems and phone line compatibility issues.

12.2 LLGT TONE ON (Y/N)

During keyups one flag is used to control whether low level guard tone is sent during a message. Some systems use logic control to the station. In these types of systems it is desirable to also place low level guard tone on the signal. Therefore, the user can easily disable this function. Note that the user may wish to shut off the notch audio flags to take advantage of the logic controlled keyups.

DISCLAIMER

Minor adjustments to the following low level guard tone parameters can optimize for special system conditions. Radical changes may produce indeterminate decoder performance.

12.3 DECODE FREQUENCY TOLERANCE (0 to 255 Hz)

This parameter is only changeable by requesting to modify decode parameters. This parameter sets the decode frequency tolerance for low level guard tone. Obviously some tolerance to frequency variations is required to compensate for tolerances in the guard tone source variations and to compensate for both resolution and tolerance problems on the comparator side. As far as the comparator goes, both resolution and tolerances are good enough to allow operation with a frequency tolerance of about 10 Hz (2185 to 2165) but other products (and phone lines) are not quite that good.

12.4 DECODE LEVEL TOLERANCE (0 to 50 dB)

In order to further increase the reliability of the tone decoder, an added level restriction was placed on detection. The source of this parameter measurement plays a crucial role in it's value. Using the analog to digital converter a measurement of the incoming signal is made. This measurement has very little resolution so care must be exercised so that the user does not request more precision than the A/D can provide.

12.5 DECODE TONE ACTIVITY TME (0 to 10000 msec)

This time parameter determines how long after low level guard tone detect has been lost before the comparator assumes that the signal has shut down. If this parameter is set too low the comparator could drop out prematurely, while setting it too large will cause the comparator to stay keyed long after the console has dekeyed.

12.6 DECODE ACTIVITY THRESHOLD (0 to 50 dB)

During a message from the console there are many times when the inbound audio totally swamps the low level guard tone detectors ability to detect. During these times the comparator can stay keyed on activity only. This threshold parameter can be used to set how much activity is required to keep the comparator keyed. The threshold is always relative to the measured level of high level guard tone for each message. Therefore, it is important to set the high level guard tone level properly. If this parameter is set too low, the comparator may stay keyed on input line noise, while setting it too high will make it difficult to keep the comparator keyed. Ideally, the level should be set so that it is just above the level of audio required to swamp out the low level guard tone detector. Noisy phone lines could mean that a higher threshold is required.

12.7 DECODE INTEGRATOR UP GAIN (0 to 100%)

As the low level guard tone detector operates, it maintains an integrator to determine if the tone is present. When this integrator reaches 100%, tone detection is achieved. Each good tone segment increments the level of the integrator by the integrator up gain amount. By setting the integrator up gain to a large number the user can increase the amount of good tone required to signal detection, while decreasing it's value means more good tone is required. This parameter is tied to the duration of low level guard tone, so when the user modifies the duration, this parameter is scaled to achieve detect in the new time frame. By selecting to modify the extra decode parameters for low level guard tone the user has an opportunity to further adjust this parameter.

12.8 DECODE INTEGRATOR DOWN GAIN (0 to 100%)

This parameter is very similar to the Up Gain parameter previously discussed and is used as the decay factor when a tone segment is received that does not resemble low level guard tone. This parameter needs to be set so that if a different tone is being received the tone decoder will not false detect, and yet noise will not cause the integrator to be zeroed out too quickly.

12.9 DECODE VARIANCE THRESHOLD (0 to 255)

The low level guard tone variance determines just how much variance can be in the low level guard tone. Each cycle of the incoming guard tone is recorded. If the average period of the incoming cycles are close enough to the guard tone frequency, detection occurs. In addition, the variance of the periods is also analyzed. A high variance indicates that there are other frequencies present (possibly voice or noise), while a low variance indicates that the tone is virtually pure. By adjusting the variance parameter the user may select the amount of special purity required to allow tone detection.

13. EDIT MEMO

To edit the MEMO field of the personality the M command is used as follows. The memo is entered by typing in a single line of up to 32 characters followed by a carriage return. If a mistake is made, then simply repeat this 'M' command until the memo is as desired. This parameter can be used at the user's discretion and does not affect operation. Used with the date command, a simple audit trail can be setup to document the personality settings, (or who made the last changes).

```
M
The current memo is:
Type in the new memo followed by <return>.
John Doe's DIGITAC
```

14. EDIT FUNCTION TONE PARAMETERS

The user can control several parameters that concern function tone. All parameters in this section can be accessed using the 'N' command.

```
N
FUNCTION TONE PARAMETERS:
To accept (DEFAULT) value: type <d> or <D>.
To accept CURRENT value: type <return>.
To CHANGE: type desired value then <return>.
Level ( dB0 ) = ( -10 ) -10: -10
Duration (msec) = ( 40 ) 40: 40
Enter Function Tone Frequencies>
Use zero ( 0 ) to turn off the function tone
Clear FT number 1 (Hz) = (1950) 1950: 1950
Clear FT number 2 (Hz) = (Off) Off: Off
Coded FT number 1 (Hz) = (1950) 1950: 1950
Coded FT number 2 (Hz) = (Off) Off: Off
Number of FT to decode = (1) 1: 1
Edit FT Decode Parameters (y/n)? → y
Decode Freq Tolerance (Hz) = (30) 30: 30
Decode Level Tolerance (dB) = (10) 10: 10
Decode Activity Time (msec) = (60) 60: 60
Decode Function Integrate Time (msec) = (10) 10: 10
Decode FT Variance Threshold = (101) 101: 101
Finished
```

14.1 LEVEL (0, -10, -20, -30 dB)

This parameter sets both the encode and decode level of function tone relative to test tone. Normally, function tones are sent through the system at -10 dB relative to test tone. the user can optionally set this level to 0, -10, -20 or -30 dB. On the tone input port, the corresponding gain will be inserted during expected periods of function tone. On the tone encode side, appropriate attenuation will be installed to get the level to comply. Yjis parameter is useful for solving cross talk problems and phone line compatibility issues.

14.2 DURATION (0 to 10000 msec)

This parameter can be used to adjust the duration of function tone. It is used on both the decode and encode side of the comparator. By selecting a longer function tone, the immunity to falsing detect increases at the expense of system access time. At this time, 40 msec seems to be the shortest recommended duration for reliable tone detection. Another parameter is provided to turn off the decoding of function tones entirely. Shortening the duration of function tones to zero is not recommended because of the effect it has on tone decoder operation.

14.3 ENTER FUNCTION TONE FREQUENCIES [Clear/Coded Keyup Tones (Tones Defined in Valid Tone List)]

The user can specify what function tones are used in front of both clear and coded transmissions. A maximum of two function tones can be programmed by the user to ensure maximum system flexibility. In addition, the user may request fewer than two function tones by following the instructions in

the editor. The function tones on all keyups, except those from the console, are the same. Console keyups are either regenerated based on what is detected, or these tone sequences are used. A common problem encountered with systems (and blamed on this parameter) is getting function tones during coded messages even though the user has shut them off. The cause of this problem is not this parameter, instead, not enough "wait" is being used before keying up to determine if a message is clear or coded. Therefore, the transmit controller is keying up clear. The "fix" needs to be installed in the keyup section.

14.4 NUMBER OF FT TO DECODE (0, 1, 2)

Up to two function tones can be used to control transmitters. For most systems it is obvious how many function tones are used. However, some systems mix the number of function tones and use different numbers for different operations. When different numbers are used in a system, the number of function tones to decode

should be set to the maximum function tone count. If a greater number of function tones are sent to the comparator than it "knows" about, the extra tones are considered to be audio and are ignored. If less function tones are sent than are expected, the comparator will time out in a predetermined amount of time (the parameter Function Tone Activity Time Out). This allows the comparator to work very well in systems designed for a constant function tone count and to work fairly well when the function tone count is left floating.

DISCLAIMER

Minor adjustments to the following function tone parameters can optimize for special system conditions. Radical changes may produce indeterminate decoder performance.

14.5 DECODE FREQ TOLERANCE (0 to 255 Hz)

This parameter is only changeable by requesting to modify decode parameters. This parameter sets the decode frequency tolerance for function tones. Some tolerance to frequency variations is required to compensate for tolerances in the function tone source variations and to compensate for both resolution and tolerance problems in the comparator. As far as the comparator goes, both resolution and tolerances are good enough to allow operation with a frequency tolerance of about 10 Hz, but other products (and phone lines) are not quite that good.

14.6 DECODE LEVEL TOLERANCE (0 to 50 dB)

In order to further increase the reliability of the tone decoder, an added level restriction was placed on detection. The source of this parameter measurement plays a crucial role in its value. Using the analog to digital converter, a measurement of the incoming signal is made. This measurement has very little resolution so care must be exercised so that the user does not request more precision than the A/D can provide.

14.7 DECODE TONE ACTIVITY TIME (0 to 10000 msec)

This parameter controls how long the comparator will wait when fewer function tones are received than are expected. In systems where a fixed function tone count is sent, this parameter is only used when noise on the tone line makes tone detection impossible. In systems where fewer than the required number of function tones are used, this parameter becomes more important. Timing for activity starts when the tone that is already being decoded has been completed. If the parameter is set too low, valid tones could be ignored. Setting this parameter to high will raise system access time during fault conditions. A number slightly larger than the expected function tone duration is suggested.

14.8 DECODE FT INTEGRATOR TIME (0 to 255 msec)

As the function tone detector operates, it maintains an integrator to determine if the tone is present. When this integrator reaches 100%, tone detection is achieved. Each good tone segment increments the level of the integrator by the integrator up gain amount. By setting the integrator up gain to a large number, the user can decrease the amount of good tone required for detection. This parameter is tied to the duration of function tone, so when the user modifies the duration, this parameter is scaled to achieve detect in the new time frame. By selecting to modify the extra decode parameters for function tone, the user has an opportunity to further adjust this parameter.

14.9 DECODE FT VARIANCE THRESHOLD (0 to 255)

The function tone variance determines just how much frequency variance can be in a function tone. Each cycle of the incoming function tone is recorded. If the average period of the incoming cycles are close enough to a valid function tone, detection is possible. In addition, the variance of the periods is also analyzed. A high variance indicates that there are other frequencies present (possibly voice or noise), while a low variance indicates that the tone is virtually pure. By adjusting the variance parameter the user may select the amount of spectral purity required to allow tone detection.

15. PRINT CURRENT SETTINGS

The current personality settings may be printed or displayed with the P command exactly the same way that the personality was viewed after power-up above. The result of the P command is shown again below. Because of the large parameter count, the comparator displays the contents of the NOVRAM one screen at a time. Pressing the spacebar will continue the printout. Pressing any other key aborts the printout.

```
P
Personality device status = good

MEMO:  John Doe's Digitac
DATE:  06/15/88
Configuration:  Conventional Coded

GENERAL PARAMETERS:
Tones at +6dB:          N
Internal Repeater Disable:  N
Internal Console Disable:  N
Internal Auxiliary Disable: N
Tones in on Console Audio Line:  N
Send Failsoft Tones to Console:  N
Transmit Audio Notch Filter:  N
Tones Out on Transmit Audio Line: N
Enable CIT Duplex Logic Input:  N
Priority Mode ( 1/2/3 ) : Console/Repeater/Auxiliary
Function Tone Filter Corner ( Hz ): 1300
Suppress Console Tone Regeneration: N
```

< HIT SPACEBAR TO CONTINUE >

```
HIGH LEVEL GUARD TONE:
Level ( dB0 ) : 0
Duration ( msec ) : 120
On for Clear Key-up : Y
On for Coded Key-up : Y
Decode Frequency Tolerance ( Hz ) : 10
Decode Level Tolerance ( dB ) : 10
Decode Integrator Up Gain ( % ) : 8
Decode Integrator Down Gain ( % ) : 16
Decode Variance Threshold : 26
```

```
LOW LEVEL GUARD TONE:
Level ( dB0 ) : -30
LLGT Tone on : Y
Decode Frequency Tolerance ( Hz ) : 10
Decode Level Tolerance ( dB ) : 10
Decode Activity Time ( msec ) : 75
Decode Activity Threshold ( dB ) : -15
Decode Integrator Up Gain ( % ) : 1
Decode Integrator Down Gain ( % ) : 1
Decode Variance Threshold : 32
```

< HIT SPACEBAR TO CONTINUE >

```
FUNCTION TONE:
Level ( dB0 ) : -10
Duration ( msec ) : 40
Clear Key-up Tones ( Hz ) : 1950, Off
Coded Key-up Tones ( Hz ) : 1950, Off
Number of FT to Decode : 1
Decode Frequency Tolerance ( Hz ) : 30
Decode Level Tolerance ( Hz ) : 10
Decode Activity Time ( msec ) : 60
Decode Integrator Time ( msec ) : 10
Decode Variance Threshold : 101
```

```

CODED:
Code Detect Time ( msec )      : 30
Code Dropout Time ( msec )     : 40
Additional Delay ( msec )      : 0
Alignment Search Depth ( msec ) : 110
Repeater Buffer Size ( msec )   : 600
Console Buffer Size ( msec )    : 600
Additional Output Delay ( msec ) : 50
Repeater Buffer Post Overflow Depth ( msec ) : 450
Console Buffer Post Overflow Depth ( msec ) : 450

```

< HIT SPACEBAR TO CONTINUE >

```

KEYUP KEYDOWN TIMING:
Console Tone Delay ( msec )      : 130
Console Clear Logic Delay ( msec ) : 40
Console Coded Logic Delay ( msec ) : 0
Repeat Clear Delay ( msec )      : 200
Repeat Coded Delay ( msec )      : 0
Clear Repeat Dropout ( msec )    : 1000
Coded Repeat Dropout ( msec )    : 250
Interrupt EOM Duration ( msec ) : 80
Turn-off EOM Duration ( msec )  : 80
Clear Re-key Delay ( msec )      : 250
Coded Re-key Delay ( msec )      : 500
Auxiliary Clear Delay ( msec )   : 150
Auxiliary Coded Delay ( msec )   : 0

```

< HIT SPACEBAR TO CONTINUE >

```

CONSOLE RECEIVE AUDIO PARAMETERS:
Console Receive Mute Time ( msec ) : 0
Notch Console Audio           : N
Transmit Tones to Console      : Y
Route Transmit Audio to Console : Y
  Allow Repeater Audio         : N
  Allow Console Audio          : N
  Allow Handset Audio          : N
  Allow Auxiliary Audio        : N

```

< HIT SPACEBAR TO CONTINUE >

```

CONTROL SEQUENCES:
Repeat Enable           : GT, 1450
Repeat Disable          : GT, 1550
Console Enable          : NOT ALLOWED
Console Disable         : NOT ALLOWED
Auxiliary Enable        : NOT ALLOWED
Auxiliary Disable       : NOT ALLOWED
Select Auxiliary Priority : NOT ALLOWED
Select Console Priority  : NOT ALLOWED
Select Repeat Priority   : NOT ALLOWED
Select First In Priority : NOT ALLOWED
Priority Revert          : NOT ALLOWED
Clear Summing Enable     : NOT ALLOWED
Clear Summing Disable    : NOT ALLOWED

```

```

FAILSOFT TONE SEQUENCE:
High Level Guard Tone   : N
Function Tones          : Off, Off

```

< HIT SPACEBAR TO CONTINUE >

```

VALID TONE LIST:
Guard Tone Frequency      : 2175
Valid Tones : 2050 1950 1850 1750 1650 1550 1450 1350 1250 1150
1050 950 850 750 650

```

```

SERIAL I / O:
New Line ASCII Characters      : <CR> <LF>
Line Length                    : 64
Character Delays ( msec )     : 4
Line Delays ( msec )          : 0

Print Out Complete

```

16. QUIT SERVICE MODE

This command is used to return to normal operation.

```

Q
Personality may have changed.
To save the personality type W.
To really exit or quit retype E or Q.

```

17. READ FROM NONVOLATILE STORAGE

This command rereads the NOVRAM data into the RAM image so one can start over again.

```

R
Nonvolatile data has been read into RAM.

```

18. EDIT CONFIGURATION

18.1 This configuration is perhaps the most important parameter supported if the operator wishes to quickly set up a system or has doubts about how parameters should be set. Internally there are two uses for the configuration variable. The first use is to define what defaults are fetched from memory when the tech command is issued. When the installer requests that defaults be fetched from memory (using the 'F' command), the configuration variable controls what defaults are fetched. For example, if the current configuration is set to Trunked Coded, the fetch operation will fetch default parameters used in a trunked coded configuration. The second use for this variable is evident in normal parameter editing. As the user adjusts parameters, a default is available for each parameter using the 'D' command. This default is dependent on the configuration. To access the Set Configuration enter 'S'.

```

S
Set Configuration
Select the configuration which most closely
matches the operating environment.
To accept CURRENT setting: type <spacebar> or <return>.
To change: type number of desired configuration.
1) Conventional Coded
2) Conventional Clear
3) Trunked Coded
4) Trunked Clear
Current Configuration: Conventional Coded
Enter Selection      :
New Selection        : Conventional Coded
Finished.

```

18.2 Currently there are four configurations supported. They are: Conventional Coded, Conventional Clear, Trunked Coded and Trunked Clear. The installer should select the configuration that most closely matches the system being installed. It is possible to quickly see what a particular configuration default looks like by setting the configuration ('S' command), fetching the defaults into memory ('F' command) and displaying the contents ('P' command). Note: As with all NOVRAM editing, the effects of the edit session are not stored until the write command has been issued ('W' command). Therefore, one can try a lot of experimentation and simply quit without writing to avoid affecting the current setup.

19. TEST NOVRAM

This command tests the NOVRAM device. If the personality device status is good then everything is "ok". If the device status is blank then the RAM image should be written to the NOVRAM. If the device status is bad there are four types of errors: a type error, a format error, a checksum error and a value out of range error. If there is a type error it probably means that the NOVRAMs of the transmit and receive side are switched. If there is a format error, this is usually caused by a software upgrade and the NOVRAM should be overwritten. If there is a checksum error, then this is most likely a bad part. One should overwrite the NOVRAM again and if the error does not go away, the part should be replaced. If there is a value out of range error then the values should be entered and written to the NOVRAM again.

```
T
Personality device status = good
```

20. EDIT KEYUP KEYDOWN TIMING

The most system dependent parameters are the key-up parameters. In order to provide 'clean' key ups, timing must be controlled. Setting key up timing would be a simple task if system access time was not a crucial factor. (Access time is the time it takes to get the system active and on the air from key up request). Several parameters can be adjusted to allow the user to achieve the best trade off between access time and clean operation. It should be noted that the defaults have been adjusted to assume worst case timing at the expense of access time. The following sections attempt to describe how a user might 'buy' back some of these trade offs if circumstances allow.

```
U
KEY-UP TIMING:
Defaults are in parentheses followed by current setting.
All values are in milliseconds.
To accept DEFAULT value type <d>.
To accept CURRENT value type <spacebar> or <return>.
To change: type desired value then <return>.
Console Tone Delay = ( 130 )      130: 130
Console Clear Logic Delay = ( 40 ) 40: 40
Console Coded Logic Delay = ( 0 ) 0: 0
Repeat Clear Delay = ( 200 )      200: 200
Repeat Coded Delay = ( 0 )        0: 0
Clear Repeat Dropout = ( 1000 )   1000: 1000
Coded Repeat Dropout = ( 250 )    250: 250
Interrupt EOM Duration = ( 80 )   80: 80
Turn-off EOM Duration = ( 80 )    80: 80
Clear Re-key Delay = ( 250 )      250: 250
Coded Re-key Delay = ( 500 )      500: 500
Auxiliary Clear Delay = ( 150 )   150: 150
Auxiliary Coded Delay = ( 0 )     0: 0
Finished.
```

20.1 CONSOLE TONE DELAY

20.1.1 When the console attempts to access the comparator there are two techniques it can use to signal this intention, either a logic input or a tone keyup sequence. When a tone keyup sequence is used, the comparator simply repeats to the station the tone information received. The timing on this operation would seem to be fairly simple. When the comparator first detects the keyup sequence it should probably start to repeat it without delay. However, if it does so and the message turns out to be coded, the last function tone may be finished before the transmit controller has enough data accumulated to allow coded operation.

20.1.2 There are two reasons that code may not be ready after the last function is sent. Internally the transmit controller requires a minimum amount of data to keep the internal data buffers operating. Until this level has been satisfied, code is not ready. This required storage is not too large a problem because in a normal system using 120 msec of guard tone, it would take 60 msec to detect it and start repeating tones. This 60 msec delay is more than enough to cover the data accumulation.

20.1.3 The other factor that affects the console tone delay is modem fast trains. If the comparator is tied to the console (CIU included) using a modem link, after the last function tone goes through the modem, a fast train needs to be sent to compensate the phone line path. This places a burst of noise after the last function and before the code reaches the comparator. This is where console tone delay comes in handy. The console tone delay parameter defines a wait time before repeating console control tones. This ensures that data is ready for the station when the last tone is sent. By increasing this time delay it is possible to cover modem fast trains. In addition to make this parameter easier to set, if it is too long and coded data is ready before the last control tone, the transmit controller will buffer coded data until the control tones are finished. This time delay could also be used to cover signaling techniques that the user wishes to cover at the front of console messages.

20.2 CONSOLE CLEAR LOGIC DELAY AND REPEAT CLEAR DELAY

20.2.1 These two parameters are similar and will therefore be discussed together. These delay parameters are used to delay keyup until it can be determined if they are coded or clear and to also mask signaling at the beginning of messages. In order to provide unique keyup sequences for coded and clear, a delay needs to be placed in front of all messages to allow enough time for code detect. For normal operation, 40 msec should be enough for code detects. If a code detect should appear during this time period the keyup can be treated as coded and the proper keyup sequences be used. If a code detect occurs after this period has elapsed, the keyup continues and the code detect is handled as if the code detect had occurred in the middle of the message. It should be noted that on the surface the keyup sequences for coded and clear are the same. However, if some coded wait time is required to ensure that data is ready after the last function tone is sent then the sequences are not the same.

20.2.2 A second use for this parameter is to mask signaling at the beginning of messages. MDC-600 (or 1200) data packets are commonly sent from a mobile in the field. It is desirable to send this audio to the console for decode but to suppress it from getting to the transmitter. This is possible by simply setting the clear wait time for repeat to approximately the duration of the signaling technique less the keyup sequence itself. A common problem encountered is either the clear keyup sequence is used for coded messages or there is a small silent gap after the last function tone is sent before code is output. It should be noted that Console Clear Logic Delay is used only on console messages that use the logic input for activation. Console messages that are signaled using control tone sequences alone do not use Console Clear Logic Delay.

20.3 CONSOLE CODED LOGIC DELAY AND REPEAT CODED LOGIC DELAY

These two parameters are used after a code detect has been discovered and before any keyup sequence is started. They are useful for ensuring that coded data is available when the keyup sequence has been completed. On the repeat side, a code detect occurs quite early but a substantial amount of time must elapse (200 msec) before data is ready in the receive portion of the comparator. Repeat Coded Logic Delay can be used to ensure that data is ready after the last function tone is sent. Like Console Clear Logic Delay, the coded delay is only used before messages originating from the console by using the logic input.

20.4 CLEAR REPEAT DROPOUT AND CODED REPEAT DROPOUT

These two parameters are used after repeater operation for supplying repeater hang time. Users familiar with repeater operation know that a repeater stays on the air for some time after the message is complete. This delay allows another user to access the system before the station has been shut down and thus lower overall access time. A delay is provided after both clear and coded messages. During this time, low level guard tone is sent to the station to keep it keyed and in the case of coded, EOM is sent to the station to keep it operating in the coded mode. If a new message is detected during the dropout time, the time is extended until the message can be repeated before the message is placed on the air, when a console message is detected the dropout is aborted and the dekey operation is commenced.

20.5 INTERRUPT EOM DURATION

There are six types of interrupt operations that can occur: the console can take over from the repeat path or auxiliary path, the auxiliary device can take over from the repeat path or console path, or the repeat path can take over from the console path or auxiliary path. The console takeover is more common while the others do

occur in some systems. When a take over is required and the message already on the air is operating in the coded mode, a small amount of EOM is required to ensure that mobiles in the field listening to the message in the field know that a switch will be taking place. This EOM is especially necessary during XL operation to avoid a long noise burst. Fortunately, the required EOM can be kept very short.

20.6 TURN-Off EOM DURATION

20.6.1 At the end of a coded message, the comparator shuts down low level guard tone. A station takes some amount of time to detect the absence of low level guard tone. If the comparator sends silence while it waits for the station to detect the keydown, it is very likely that the station will lose code detect before it loses low level guard tone. This causes the station to dekey clear, which in turn causes a noise pop on the mobile. To avoid this, the comparator can supply some EOM after low level guard tone is dropped. This ensures that the station dekeys coded.

20.6.2 For stations that are coupled to the comparator using a simple two wire interface (tones and audio mixed on same lines), it does not make sense to try and supply EOM after low level guard tone is dropped because no low level guard tone is present on the line to begin with. In addition, newer stations may remove the need for this delay and therefore the user may wish to reduce this parameter to zero.

20.7 CLEAR RE-KEY DELAY AND CODED RE-KEY DELAY

After a message has been completed, some amount of delay is needed to make sure that the station is ready to accept a new keyup (Micor stations need this). This parameter can be adjusted so that the user can be assured the station has dekeyed. Again, newer stations may allow this parameter to be dropped to zero.

20.8 AUXILIARY CLEAR DELAY

This parameter is used to delay keyup until it can be determined if it is coded or clear and to mask signaling at the beginning of messages. For normal operation 40 msec should be enough for code detects. It should be noted that this parameter is used always on auxiliary messages because they use logic input for activation.

20.9 AUXILIARY CODED DELAY

This parameter is used after a code detect has been discovered and before any keyup sequence is started. It is useful for ensuring that coded data is available when the keyup sequence has been completed. Like Auxiliary Clear Delay, the coded delay is always used before messages originating from the auxiliary device because it uses the logic input.

21. EDIT VALID TONE LIST

For the purpose of both tone encode and decode, a list of valid tones is stored internally. The v command allows the user to modify this list so that unusual tone frequencies can be supported. It can also be used to eliminate a particular tone that the user wishes to make "invisible" to the comparator. The first frequency in this table is used to define the guard tone and is therefore treated specially. It should be noted that the guard tone frequency can be changed at this level, but that since hardware modifications are also required, major changes may not be successful. All other frequencies are treated generically. Frequencies are accepted from 300 Hz to 6 kHz although tones cannot be decoded above 2500 Hz. If the user selects a frequency below 300 Hz the tone is assumed to be invalid and is removed from the list. Frequencies above 6 kHz are ignored.

```

V
Valid Tone List:
20 unique tones can be utilized by the comparator.
Defaults are in parentheses followed by current setting.
All frequencies are in Hertz.
To accept DEFAULT value: type <d>
To accept CURRENT value: type <spacebar> or <return>.
To change: type desired value then <return>.
Guard Tone Frequency      ( 2175 )      2175: 2175
Tone [ 1 ] ( 2050 )      2050:      2050
Tone [ 2 ] ( 1950 )      1950:      1950
Tone [ 3 ] ( 1850 )      1850:      1850
Tone [ 4 ] ( 1750 )      1750:      1750
Tone [ 5 ] ( 1650 )      1650:      1650
Tone [ 6 ] ( 1550 )      1550:      1550
Tone [ 7 ] ( 1450 )      1450:      1450
Tone [ 8 ] ( 1350 )      1350:      1350
Tone [ 9 ] ( 1250 )      1250:      1250
Tone [10 ] ( 1150 )      1150:      1150
Tone [11 ] ( 1050 )      1050:      1050
Tone [12 ] ( 950 )       950:       950
Tone [13 ] ( 850 )       850:       850
Tone [14 ] ( 750 )       750:       750
Tone [15 ] ( 650 )       650:       650
Tone [16 ] ( 0 )         0:         0
Tone [17 ] ( 0 )         0:         0
Tone [18 ] ( 0 )         0:         0
Tone [19 ] ( 0 )         0:         0
Finished.

```

22. WRITE TO NONVOLATILE STORAGE

This command transfers the values in the NOVRAM RAM image into the NOVRAM ROM image.

```

W
RAM image now saved in the personality device.

```

23. SET TRANSMITTER INTERCONNECT

This parameter is a macro that controls two parameters that can be set individually under their respective menus. What this command does is set the parameters needed to configure the transmitter output correctly for tones on the audio bus and for separate tones and audio. If this command is used to set up the transmitter interface then it will not be necessary to change these parameters individually.

```

X
Set tones on audio bus.
Select the desired interface.
To accept DEFAULT value: type <d>.
To accept CURRENT value: type <spacebar> or <return>.
To change: type in the number of the choice.
Parameters affected:
    Tones out on Transmit Audio Bus
    Transmit Audio Notch Filter
1 ) Combine tones and audio
2 ) Separate tones and audio
Current interface: Separate tones and audio
Default interface: Separate tones and audio
Interface choice: Separate tones and audio
Finished.

```

24. EDIT FAILSOFT PARAMETERS

In clear trunking systems the comparator is relied upon to route the failsoft indication received from the station back to the console operator. In these systems a logic signal is routed to the comparator from the station. When the station loses its connection to the central controller, it asserts the failsoft line to the comparator. The comparator then needs to convey this information back to the console operator. However, the console is typically remotely located from the comparator so a simple wire connection is not possible. Instead, the comparator sends a control tone sequence back to the console and maintains low level guard tone until the failsoft has been fixed. The following parameters simply control what control sequence is sent back during failsoft.

```
Z
EDIT FAILSOFT PARAMETERS:
To accept (DEFAULT) value: type <d> or <D>.
To accept CURRENT value: type <return>.
To CHANGE: type desired value then <return>.

Should HLGT be used in Failsoft (y/n) = (N) N:      N
Enter Function Tone Frequencies for use in Failsoft
Use zero ( 0 ) to turn off the function tone
First FT for Failsoft (Hz) = (Off) Off: Off
Second FT for Failsoft (Hz) = (Off) Off: Off
Finished.
```

24.1 FAILSOFT HIGH LEVEL GUARD TONE

This parameter allows the user to specify whether or not high level guard tone is used during failsoft mode. The duration and level are set in the high level guard tone section.

24.2 FAILSOFT FUNCTION TONES

This parameter defines the function tones sent back during failsoft. Currently trunking systems do not use any function tones during failsoft but these parameters allow future enhancements.

25. DEFAULT NOVAM SETTINGS FOR DIFFERENT SYSTEM TYPES

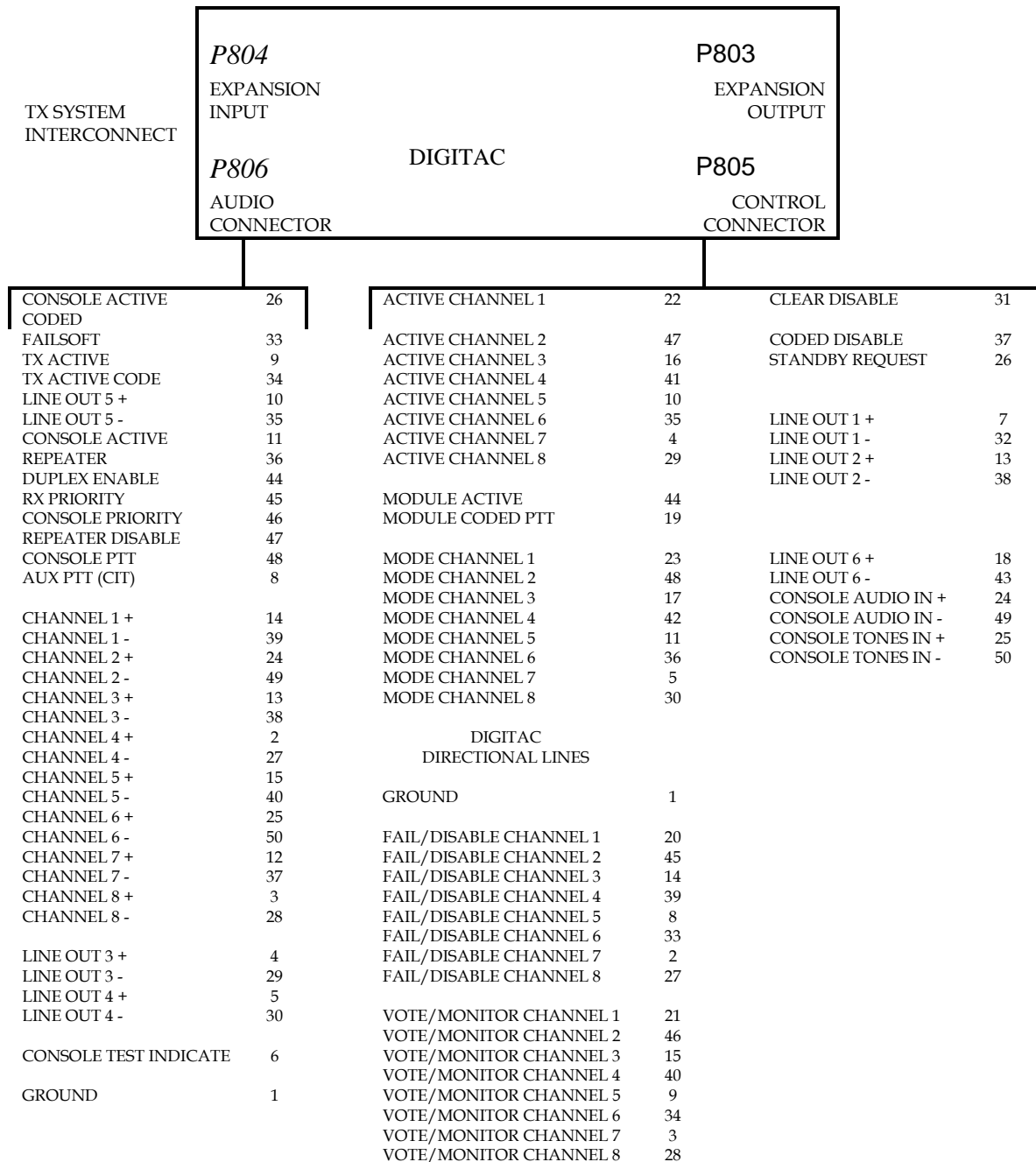
Configuration	:Conventional Coded	:ConventionalClear	:Conventional Coded	:Conventional Clear
GENERAL PARAMETERS: [G]				
Tones at +6dB	:N	:N	:N	:N
Internal Repeater Disable	:N	:N	:N	:N
Internal Console Disable	:N	:N	:N	:N
Internal Auxiliary Disable	:N	:N	:N	:N
Tones In on Console Audio Line	:N	:Y	:Y	:Y
Send Failsoft Tones to Console	:N	:N	:N	:Y
Transmit Audio Notch Filter	:N	:Y	:Y	:N
Tones Out on Transmit Audio Line	:N	:Y	:Y	:N
Enable CIT Duplex Logic Input	:N	:N	:N	:Y
Priority Mode (1/2/3)	:Console/Repeater/Aux	:Console/Repeater/Aux	:Console/Repeater/Aux	:Console/Repeater/Aux
Function Tone Filter Corner	:1300	:1300	:1300	:1300
Suppress Console Tone Regeneration	:N	:N	:N	:Y
HIGH LEVEL GUARD TONE: [A]				
Level (dB0)	:0	:0	:0	:0
Duration (msec)	:120	:120	:60	:60
On for Clear Key-up	:Y	:Y	:Y	:N
On for Coded Key-up	:Y	:N	:N	:N
Decode Frequency Tolerance (Hz)	:10	:10	:10	:10
Decode Level Tolerance (dB)	:10	:10	:10	:10
Decode Integrator Up Gain (%)	:8	:8	:16	:16
Decode Integrator Down Gain (%)	:16	:16	:32	:32
Decode Variance Threshold	:26	:26	:26	:26
LOW LEVEL GUARD TONE: [L]				
Level (-dB0)	:30	:30	:30	:30
LLGT On	:Y	:Y	:Y	:Y
Decode Frequency Tolerance (Hz)	:10	:10	:10	:10
Decode Level Tolerance (dB)	:10	:10	:10	:10
Decode Activity Time (msec)	:75	:75	:75	:75
Decode Activity Threshold (-dB)	:15	:15	:15	:15

Decode Integrator Up Gain (%)	:1	:1	:1	:1
Decode Integrator Down Gain (%)	:1	:1	:1	:1
Decode Variance Threshold	:32	:32	:32	:32
FUNCTION TONE: [N]				
Level (-dB0)	:10	:10	:10	:10
Duration (msec)	:40	:40	:40	:40
Clear Key-up Tones (Hz)	:1950, Off	:1950, Off	:Off, Off	:Off, Off
Coded Key-up Tones (Hz)	:1950, Off	:Off, Off	:Off, Off	:Off, Off
Number of Function Tones to Decode	:1	:1	:0	:0
Decode Frequency Tolerance (Hz)	:30	:30	:30	:30
Decode Level Tolerance (dB0)	:10	:10	:10	:10
Decode Activity Time (msec)	:60	:60	:60	:60
Decode Integrator Time (msec)	:10	:10	:10	:10
Decode Variance Threshold	:101	:101	:101	:101
CODED: [K]				
Code Detect Time (msec)	:30	:30	:30	:30
Code Dropout Time (msec)	:40	:40	:40	:40
Additional Delay (msec)	:0	:0	:0	:0
Alignment Search Depth (msec)	:110	:110	:110	:110
Repeater Buffer Size (msec)	:600	:600	:600	:600
Console Buffer Size (msec)	:600	:600	:600	:600
Additional Output Delay (msec)	:50	:50	:50	:50
Repeater Buffer Post Overflow Depth	(msec):450	(msec):450	(msec):450	(msec):450
Console Buffer Post Overflow Depth	(msec):450	(msec):450	(msec):450	(msec):450
KEYUP KEYDOWN TIMING: [U]				
Console Tone Delay (msec)	:130	:0	:0	:0
Console Clear Logic Delay (msec)	:40	:0	:0	:0
Console Coded Logic Delay (msec)	:0	:0	:0	:0
Repeat Clear Delay (msec)	:200	:0	:0	:0
Repeat Coded Delay (msec)	:0	:0	:0	:0
Clear Repeat Dropout (msec)	:1000	:1000	:0	:0
Coded Repeat Dropout (msec)	:250	:0	:0	:0
Interrupt EOM Duration (msec)	:80	:0	:80	:0
Turn-off EOM Duration (msec)	:80	:0	:0	:0
Clear Rekey Delay (msec)	:250	:250	:0	:0
Coded Rekey Delay (msec)	:500	:500	:0	:0
Auxiliary Clear Delay (msec)	:150	:0	:0	:0
Auxiliary Cided Delay (msec)	:0	:0	:0	:0
CONSOLE RECEIVE AUDIO PARAMETERS: [B]				
Console Receive Mute Time (msec)	:0	:0	:0	:0
Notch Console Audio	:N	:N	:N	:Y
Transmit Tones to Console	:N	:N	:N	:N
Route Transmit Audio to Console	:N	:N	:N	:N
Allow Repeater Audio	:Y	:Y	:Y	:Y
Allow Console Audio	:Y	:Y	:Y	:Y
Allow Handset Audio	:Y	:Y	:Y	:Y
Allow Auxiliary Audio	:Y	:Y	:Y	:Y
CONTROL SEQUENCE: [C]				
Repeat Enable	:GT,1450	:GT,1450	:Selectable	:Selectable
Repeat Disable	:GT,1450	:GT,1450	:Selectable	:Selectable
Console Enable	:Selectable	:Selectable	:Selectable	:Selectable
Console Disable	:Selectable	:Selectable	:Selectable	:Selectable
Auxiliary Enable	:Selectable	:Selectable	:Selectable	:Selectable
Auxiliary Disable	:Selectable	:Selectable	:Selectable	:Selectable
Select Auxiliary Priority	:Selectable	:Selectable	:Selectable	:Selectable
Select Console Priority	:Selectable	:Selectable	:Selectable	:Selectable
Select Repeat Priority	:Selectable	:Selectable	:Selectable	:Selectable
Select First In Priority	:Selectable	:Selectable	:Selectable	:Selectable
Priority Revert	:Selectable	:Selectable	:Selectable	:Selectable
Clear Summing Enable	:Selectable	:Selectable	:Selectable	:Selectable
Clear Summing Disable	:Selectable	:Selectable	:Selectable	:Selectable
FAILSOFT TONE SEQUENCE: [Z]				
High Level Guard Tone	:N	:N	:N	:Y
Function Tones	:Off, Off	:Off, Off	:Off, Off	:Off, Off
VALID TONE LIST: [V]				
Guard Tone Frequency	:2175	:2175	:2175	:2175
Valid Tones	:2050 1950 1850 1750 1650 1550 1450 1350	:2175 1250 1150 1050 950 850 750 650		
SERIAL I/O: [I]				
New Line ASCII Characters	:<CR><LF>	:<CR><LF>	:<CR><LF>	:<CR><LF>
Line Length	:65	:65	:65	:65
Character Delays (msec)	:4	:4	:4	:4
Line Delays (msec)	:0	:0	:0	:0

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25. EXTERNAL CONNECTIONS

The following chart is similar to the Digitac System Interconnect Diagram in the Digitac manual. The chart shows the pin numbers associated with line ins, line outs, and other control lines. The chart is here for quick reference only when using this system guide.



OPTION C618AB-SP THROUGH C618AF-SP AND QVN4119A RETROFIT KIT CODED VOTE/HOLD OPERATION

1. DESCRIPTION

Options C618AB-SP through C618AF-SP add a new feature to the DIGITAC™ Comparator voting operation. These options use Release 1.15 Receive Operating Firmware which makes it possible for the comparator to "hold" the first voted coded channel for a set amount of time. It is also possible for the comparator to indefinitely "lock" the coded vote mode to the first chosen channel for the entire keypad duration.

By locking the vote, no changes in channel voting are allowed. All other *Digitac* functions operate as before. After the hold time has expired, the vote is allowed to transition normally.

Options C618AB-SP through C618AF-SP are compatible with all other *Digitac* transmit control operating firmware.

2. MODEL COMPLEMENT

The Coded Vote and Hold options apply to the *Digitac* Comparator main model series as follows:

OPTION	MAIN MODEL SERIES
C618AB-SP	Q2980A/81A --- 4, 8 Channel Capability

C618AC-SP	Q2982A/83A --- 12, 16 Channel Capability
C618AD-SP	Q2984A/85A --- 20, 24 Channel Capability
C618AE-SP	Q2986A/87A --- 28, 32 Channel Capability
C618AF-SP	Q2988A/89A --- 36, 40 Channel Capability

Each of the Coded Vote and Hold options adds a QRN5156A Coded Vote and Hold Kernel Board to the *Digitac* Comparator. The QRN5156A is the same as the QRN4304B Kernel Board described in the *Digitac* instruction manual (68P06908B19) except for the replacement of U30, U31, U32 and U33 as described in paragraph 4 of this instruction manual.

3. OPERATION

The new parameter described above is called "Coded Hold Time" which defaults to 0 ms (no hold time). This parameter is listed with the other receive side parameters under the Coded section. A typical printout could look like Figure 1 on the following page (user inputs are in bold face).

SECURENET DIGITAC COMPARATOR
 RECEIVE SOFTWARE VERSION 1.15
 COPYRIGHT MOTOROLA INC. 1986, 1991
 ALL RIGHTS RESERVED

Performing self-tests

.....
 Module ID: 0001 Two Input Boards present
 All tests passed
 Self-test complete

P

Personality device status = good

MEMO:

DATE:

GENERAL:	1	2	3	4	5	6	7	8
Line failure time (sec)	60	60	60	60	60	60	60	60
Activity threshold (dBm0)	-14	-14	-14	-14	-14	-14	-14	-14
Disable requests (Y/N)	N	N	N	N	N	N	N	N

Output status tone enables: primary = Y aux - Y

CLEAR:

(times are in msec, hysteresis is in dB)

Settle time = 150	Hold time = 850	Sample period = 0
Mute time = 150	Hysteresis = 2	Clear disable = N

CODED:

(times are in msec, disable is Y/N)

Code detect time = 30	Code dropout time = 60
Diff. input delay = 128	Additional delay = 0
Voting buffer pad = 39	Output buffer pad = 40
Coded disable = N	Coded hold time = 0

SERIAL I/O:

New line ASCII characteristics = <CR> <LF>	Line length = 80
Delays (msec): character = 4	line = 0

Figure 1. Typical Receive Software Version 1.15 Printout

The hold time can range from 0 (min) to 65535 (max). Although any integer in this range is allowed, only values in multiples of 50 ms are meaningful. For example, if a value of 35 ms is used, the vote will be held for 50 ms. If a value of 201 ms is used, the vote will be held for 250 ms. Any value out of range is rejected.

A value greater than 60000 ms (1 minute) has unique meaning. When a value in this range is used, the *Digitac* will hold the coded vote for the entire length of the transmission no matter how long. The *Digitac*

will respond with "forever" when viewing the coded mode vote and hold time.

If the value of the coded hold time is to change from its default value of 0 ms, it is also required to increase a transmit side parameter on the *Digitac* Comparator. This parameter is called "additional output delay" and is in the coded subsection under buffer parameters. In order to prevent buffer underflows which lead to EOM injection, a value of 70 ms is suggested (default is 50 ms). Refer to Figure 2.

K

CODED:

Defaults are in parentheses followed by current setting.

All values are in milliseconds.

To accept DEFAULT value: type <d>.

To accept CURRENT value: type <spacebar> or <return>.

To change: type desired value then <return>.

Code Detect Time = (30) 30 : 30

Code Dropout Time = (40) 40 : 40

Additional Delay = (0) 0 : 0

Edit Buffer Parameters? (y/n) → Y

Alignment Search Depth = (110) 110: 110

Repeater Buffer Size = (600) 600: 600

Console Buffer Size = (600) 600: 600

Additional Output Delay = (50) 70 : 70

Repeater Buffer Post Overflow Depth = (450) 450 : 450

Console Buffer Post Overflow Depth = (450) 450 : 450

Nominal Coded Throughput Delay = 194

Finished.

Figure 2. Additional Output Delay Typical Printout

There are instances when the *Digitac* Comparator is comprised of more than one chassis. In this case the amount of coded hold time must be set in each individual chassis. The value that is input for each chassis should be the same.

An example showing a typical ending session is shown in Figure 3. In the example the value of the coded hold time is set for 700 ms. The vote can be "locked" by entering a value greater or equal to 60000 msec.

```

S
Do you wish to enter service mode?    (y/n) → Y
Now in service mode. Type H or ? for help.
P
Now editing the personality.
K
Private (coded) mode parameters:
To accept current value: type <return>.
To change: type desired value then <return>.
All values are in msec.
Code detect time (nom)          = 30      30
Code dropout time (nom)         = 60      60
Max input delay diffrnc         = 128     128
Additional delay (nom)          = 0        0
Coded hold time (nom)           = 0      700  700
Do you want to edit the buffer pad sizes? (y/n) → n
Resulting coded throughput delay (nom)   = 241
Coded disable (y/n) = N    N
Finished.

```

Figure 3. Typical Ending Session Printout

4. QVN4119A RETROFIT KIT INSTALLATION

The QVN4119A Retrofit Kit upgrades a *Digitac* Comparator to version 1.15 operating firmware and enable coded vote and hold operation. Four 28-pin EPROMs (U30 through U33) on the *Digitac* Comparator Kernel board are replaced with the new EPROMs shown in the following chart.

EPROM	NEW PART NUMBER
U30	5106147E79
U31	5106147E80
U32	5106147E81
U33	5106147E82

For multiple chassis configurations each Kernel board must have the same EPROMs replaced to incorporate the updated firmware. each chassis should have the "hold time" parameter set to the same value. All other multi-chassis operations operate as usual.



DIGITAC™ COMPARATOR

LOCKED PERSONALITY PARAMETERS – VOTING SELECTION

Note: Modifying locked parameters could impair system performance.

To access locked parameters you must press U after entering service mode but before entering personality editing.

When the comparator is operating in coded mode, it creates two signals internally as part of the voting process. The first is what is called the Best signal and is merely the data stream from the best channel. The second is the majority signal which is the bit by bit majority of all time aligned inbound signals. When an even number of channels are present, ties are broken by deciding in favor of the group that includes the best channel. This produces a slight improvement in Majority voting. Selection of which internal signal is produced at the output can be performed either automatically by the comparator or by setting two of the locked parameters. When the automatic operation is selected the decision is based on current operating conditions. However when the comparator was designed it was clear that some system conditions might make it impossible for the software to decide the correct operating mode. Therefore two parameters were provided to provide this capability.

The following table describes how the comparator works when automatic selection is chosen. The comparator was designed to favor Best voting to ensure that it would not accidentally corrupt a very good signal when two poor ones were being received. It is interesting to note that the error rates

experienced in CFB systems, there are no bad signals and the comparator is hard pressed to make a bad decision. Problems can arise when the comparator is operated in a system optimized for XL but operating CFB. With this sort of system, XL works very well because any possible corruption is below the audible level. However it is possible to corrupt a perfect CFB signal with very bad XL level signals and notice the degradation on the Majority signal. One must be cautious about selecting Majority voting all the time because of this possible corruption. Selecting best voting will only eliminate any diversity enhancements that the comparator was designed to take advantage of. Glitchless coded voting is still operational. It should be noted that the comparator can switch between Best and Majority voting "on the fly" without causing bit errors or slips.

Number of Channels Active	Voting Operation	Comment
1 – 2	Best	No majority is really possible so the question is moot.
3 – 4	Either	Based on the spread between the best and the worst channel.
5 - n	Majority	This many channels make the majority virtually perfect

When the user requests Best or Majority voting the comparator will make no decision about the current operating conditions but will





simply do as it is requested. The following table shows the requests and the result (YES and NO are the responses the user would give):

Majority Request	Best Request	Operation
NO	NO	Automatic (default)
YES	NO	Majority Voting
NO	YES	Best Voting
YES	YES	Contradictory Best Voting





DIGITAC™ COMPARATOR MUSICAL TUNES

DIGITAC TUNES

Here's how:

Enter service mode on TX board.
Type J then X.

enter the following UPPER CASE letters:

LETTER	TUNE
B	happy birthday
C	jingle bells
F	frosty the snowman
J	james bond theme
O	bach
T	taps
E	1812 overture

some lower case letters play notes. Not being a musical kind of guy, I don't know what's what, but the chars

z s x c f y g b n j m k, l . /

all make noise. In addition, you can shift octaves by typing a number (0-9) before the char.

Note that the 1812 overture is buggy...causes DIGITAC to hang.

q or Q will reset DIGITAC.

The source code is in:

//sc5/v1/org/secure_comm/proj/windex/d
ev/tx/src_libs/source/p_tones.c